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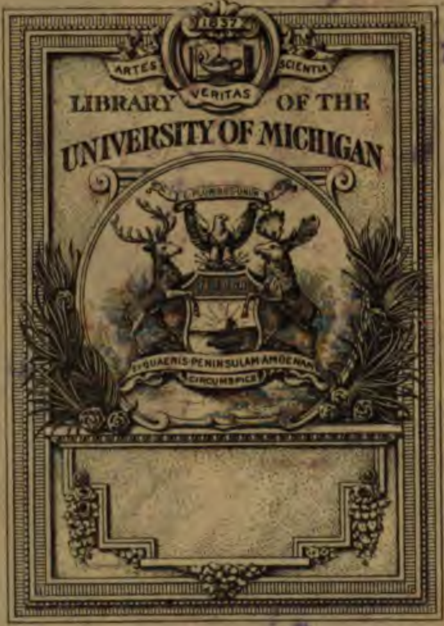

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# ANNUAL REPORT

OF THE

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# SECRETARY OF WAR

FOR

## THE YEAR 1893.

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IN FOUR VOLUMES.

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## VOLUME II–IN SIX PARTS.

**PART 3.**

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TO THE

# REPORT OF THE CHIEF OF ENGINEERS,

UNITED STATES ARMY.

(CONTINUED.)

# APPENDIX R.

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## INSPECTION OF THE IMPROVEMENT OF THE SOUTH PASS OF THE MISSISSIPPI RIVER.

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### *REPORT OF MAJ. JAMES B. QUINN, CORPS OF ENGINEERS, INSPECTING OFFICER, FOR THE FISCAL YEAR ENDING JUNE 30, 1893.*

UNITED STATES ENGINEER OFFICE,
*New Orleans, La., July 1, 1893.*

GENERAL: I have the honor to submit my annual report upon the improvement of South Pass of the Mississippi River for the fiscal year ending June 30, 1893.

During the year a very considerable shoaling occurred at the head of the passes of the Mississippi River, within the limits of the surveys, and, during the period of high water, sand bars formed above the entrance to South Pass and eventually extended into the pass itself so as to reduce the depth to less than that required to be maintained by the executors of the Eads' estate.

Shoaling also took place at a point about 1⅜ miles below the head of the passes light-house, and this shoal has been most persistent; and, although for a time the channel was restored, at the time of closing this report it has shoaled up again.

Navigation has been materially interfered with in consequence of this shoaling, and the complaints of ship agents have been unusually numerous.

The remainder of the pass and the channel across the bar have not been appreciably changed by this unusual flow of sand, and have not, therefore, required the attention which it has been found necessary to give to the places before mentioned.

The surveys represented on the charts herewith were made at times when the least changes were occurring in the channel, and do not therefore show the condition of affairs when the deficiencies existed. Supplemental examinations were made from time to time, however, and the results of these examinations were transmitted to the Engineer Department. The extra time involved in making these supplemental examinations has prevented, in a measure, the completion of the survey in the gulf, at the mouth of the pass, which is usually made to determine the amount of shoaling in advance of the jetties.

The chart of the sea end of the jetties shows a gradual growth of the bar, and clearly indicates the early resumption of those conditions which obtained before the jetties were constructed. If it is therefore desirable to maintain the present 30-foot depth of channel through this bar, the early extension of the jetties is patent to any unprejudiced observer.

The bar directly in front of the entrance has shoaled to such an
tent that the current is strongly deflected to the eastward, and in
sequence, under unfavorable conditions of wind, vessels endeavorin
make the entrance are liable to be carried onto this bar and wreck

The principal work upon the jetties has been applied to the const
tion of wing dams and repairs to the inner lines of jetties. Some a
tions to the outer lines of the east jetty at the land end were made
prevent the encroachments of the sea from breaking through at t
point. The permanent character of the jetty structure is already
veloped in doubt, since the teredo has attacked the lower course of
timber capping of a portion of the jetty.

To maintain the required depth of channel, the dredge boat has b
employed seventy-three days of ten hours each, the greater portion
which time was spent in dredging between the jetties and beyond th
ends in the Gulf.

It is possible that the 30-foot channel at the Gulf entrance may
successfully maintained a few years longer by energetic dredging, b
it is evident that it will not be a great while before the prolongat
of the jetties will become necessary.

The shoaling of the entrance to Southwest Pass at its head and t
deepening of the channel into Pass a Loutre indicate a decay of Sou
west Pass, and, since the works at the head of South Pass were c
structed when this was the most active pass, it is likely that so
rearrangement of the dams, etc., at the head of South Pass may
necessary to meet the changed conditions of flow and to preserve t
required depth.

The report of Mr. C. Donovan, assistant engineer, with accompa
ing charts, is herewith, and gives all details of the construction wo
done during the year, the present condition of the works, and t
results they have produced.

*Estimate of funds required for examinations and surveys at South Pass, Mississippi Ri during the fiscal year ending June 30, 1895.*

| | |
|---|---|
| 1 assistant engineer | $2, |
| 1 recorder | 1, |
| 1 steam engineer | 1, |
| 1 water-level observer | |
| 6 seamen | 3, |
| Rent of office | |
| Rent of quarters for assistant engineers | |
| Mileage and traveling expenses | |
| Repairs to launch and boats | |
| Supplies for launch and office | |
| Contingencies | 1, |
| Total | 12, |

*Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $799. |
| Amount appropriated by act approved August 11, 1888 | 10,000. |
| | 10,799. |
| June 30, 1893, amount expended during fiscal year | 8,946. |
| July 1, 1893, balance unexpended | 1,852. |
| Amount appropriated by act of August 11, 1888 | 10,000. |
| Amount available for fiscal year ending June 30, 1894 | 11,852. |
| Amount that can be profitably expended in fiscal year ending June 30, 1895 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893. | 12,410. |

*Statement of expenditures on account of appropriation for "examinations and surveys at South Pass, Mississippi River," for the fiscal year ending June 30, 1893, made in compliance with section 4 of river and harbor act of August 11, 1888.*

Amount appropriated by act of August 11, 1888 .......... $10,000.00

EXPENDITURES.

| | |
|---|---|
| 1 assistant engineer, 12 months, at $200 | $2,400.00 |
| 1 recorder, 12 months, at $100 | 1,200.00 |
| 1 engineer launch, 12 months, at $100 | 1,200.00 |
| 1 first-class seaman, 12 months, at $70 | 840.00 |
| 2 first-class seamen, 24 months, at $65 | 1,560.00 |
| 1 first-class seaman, 12 months, at $60 | 720.00 |
| 1 first-class seaman, 2½ days, at $2 | 5.00 |
| 1 water-level observer, 12 months, at $10 | 120.00 |
| 1 clerk, 1 month, at $100 | 100.00 |
| 1 clerk, ½ month, at $90 | 45.00 |
| Rent of office and quarters at Port Eads, La., 12 months, at $35 | 420.00 |
| | 8,610.00 |
| Traveling expenses, assistant engineer | 30.50 |
| Stationery | 20.00 |
| Repairs to steam launch *General Reese* | 277.39 |
| Ship chandlery, hardware, etc | 6.54 |
| Telegrams | 2.30 |
| Total expenditures | 8,946.73 |

Respectfully submitted.

JAMES B. QUINN,
*Major, Corps of Engineers.*

Brig. Gen. THOMAS L. CASEY,
*Chief of Engineers, U. S. A.*

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### REPORT OF MR. C. DONOVAN, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
*Port Eads, La., July 1, 1893.*

SIR: I have to report for the fiscal year ending June 30, 1893, relative to the improvement of the South Pass of the Mississippi River, the amount and character of the work done during the year, the present condition of the works, and the results which they have produced as ascertained by examinations and surveys made for that purpose.

The work required for this improvement is still carried on under the direction of Messrs. James F. How and Estill McHenry of St. Louis, Mo., by authority granted them, as the legal representatives of James B. Eads, deceased, in an act of Congress approved March 3, 1875.

The following charts accompany this report:

No. 1. Chart of the channel from South Pass light-house, through the jetties, to deep water in the Gulf.

No. 2. Chart of a part of South Pass, from South Pass light-house to Grand Bayou.

No. 3. Chart of a part of South Pass, from Grand Bayou to the Head of the Passes.

No. 4. Chart of the Head of the Passes.

No. 5. Plan and comparative profiles of South Pass.

#### AT THE HEAD OF THE PASSES.

*West T-head.*—During the month of April the piling near the upper end of this work began to incline toward Southwest Pass, and seemed to indicate that it might be undermining. On examination, however, the mattress work was found to be undisturbed. A backing of piling was put in at the upper end, and connected by bracing with the main work so as to hold it in place.

Willows weighted mostly with earth were added to the structure; although the piling and other timber work above the water is badly decayed, the mattress work remains as originally placed, rendering the work substantial. The upper surfac the work is 2 feet above the average flood tide.

The following materials were used in this work: 109 linear feet of 12 by 12 i timber, 116 linear feet of 4 by 8 and 2¼ by 6 inch scantling, 6 piles, 25 screw b 26 inches long of seven-eighths inch iron, 224 cords of willows, and 13 cubic yard stone.

*Wing Dam.*—During last month a wing dam projecting from the east shore point 50 feet below the east light was built in order to concentrate the current increase its scouring power, to the end that the channel might be cleared of the s which was being deposited at this locality.

The structure though intended to be only temporary effectually served the p pose for which it was built, and soon after its completion the channel improved r idly. During the night of June 22, a portion of the dam washed out.

This dam was 95 feet long, and consisted of two rows of piles 8 feet apart, piles in each row being 6 feet apart, and are connected by 12 by 12 inch timl bolted to them; cross-ties are then bolted to these horizontal timbers to prevent rows of piles from spreading apart when willows and stone are placed between th

The following materials were used in this dam: 28 piles, 227 linear feet of 12 12 inch timber, 27 screw bolts, 223 cords of willows, and 22 cubic yards of stone.

*Upper dam.*—But 350 feet of this dam now remains intact, 162 feet having wasl out during the year. Of this distance 100 feet was from the west end and 62 f from the east end. By reference to chart No. 4 it will be seen that the portion this dam still in place is well backed by the land formation below it, and as the e end has been holding very well for several months, it seems possible that this w may not be further encroached upon to accommodate the flow into Pass a Loutre

*Mattress sill across Southwest Pass.*—As nearly as can be ascertained about 200 f of this work washed out during the year. Its present condition is as follows: Co mencing at a point 100 feet from the east end of the sill, there is 600 feet in len which has disappeared, thence for a distance of 500 feet it has settled an amou varying from 3 to 15 feet since 1879, and over the remainder of its length the sett ment has been about 2 feet since that year.

*Mattress sill across Pass a Loutre.*—For a distance of 2,100 feet from the east end this sill it is covered with a heavy deposit of sand so that the depth of water o it is less than when it was placed in 1877. A portion of the west end, probal about 500 feet in length, was washed out during the year.

The strong current at this locality continues to destroy the east dike which many years remained buried by deposits which the works of construction caused.

The location of all the works at the Head of the Passes is given on Chart No. 4

### IN SOUTH PASS.

One wing dam, No. 10, was built in Goat Island Reach, numbers 1 and 5 were built, and numbers 2 and 9 received additional willows which were weighted wi earth.

With reference to these constructions it need only be said that a general pl which has been followed for several years is still adhered to. Willows confin between parallel rows of piles which are tied and cross-tied to give the structu stability, is the general plan.

No. 10 is 43 feet long and seven feet wide, No. 5 is 114 feet long, and for one-h its length it is 15 feet wide; the other half is 8 feet wide and as it is in shoal wa the willows are confined between stakes. No. 1 is 78 feet long, and for 63 feet it 20 feet wide, for 15 feet it is 10 feet wide, and the willows are confined between ro of stakes.

In the construction and repair of dams in this reach the following materials we used: 73 piles, 469 linear feet of 12 by 12 inch timber, 73 screw bolts, 442 co of willows, and 74 cubic yards of stone.

The wing dams in Grand Bayou Reach are shown on charts 3 and 4. Two new o were built last month; they are Nos. 13 and 14. They project from the east sh and are respectively 93 feet and 52 feet long, and 8 feet wide.

Dams number 3, 4, 6, 7, 8, 9, 10, 11, 12, were repaired or had material added them during the year, so that all these structures which are considered essential a now in good condition. The following materials were used in their constructi and repair: 97 piles, 565 linear feet of 12 by 12 inch timber, 44 drift bolts, 51 scr bolts, 488 cords of willows, and 37 cubic yards of stone.

A small bayou leading from South Pass into Garden Island Bay, at a point abo one-half mile below Grand Bayou was closed with 16 cords of willows, and 10 cub yards of stone.

At a point about 1¼ miles below Grand Bayou the land between the pass and t bay was cutting away on the bay side, forming a small indentation in the sh which might eventually extend to the bank of the pass and form a small outlet in the bay. The progress of this cutting away was arrested by building a dam 82 fe long and 8 feet wide, consisting of 30 piles in two parallel rows, between which 72 cords of willows and 20 cubic yards of stone were placed.

### AT THE MOUTH OF SOUTH PASS.

*East Jetty.*—Two cribs were added to the capping of this jetty, which brings it to a point 3,960 feet below East Point. At the end of the last crib and on the sea side of it is another, with its length at right angles to the jetty.

In connection with the protection of this jetty by preventing, if possible, any further recession of the land formation on the eastward of it, two cribs were placed nearly at right angles to the shore and at distances of 500 and 1,500 feet from the jetty. The impression was that these would arrest the current along the shore and, to some extent at least, prevent its further recession.

Those placed on the jetty are 54 and 60 feet long, 8 feet wide, and 4½ feet high; the one placed at right angles to the jetty is of the same dimensions except the length, which is 56 feet. Those placed to arrest the recession of the shore are 231 and 239 feet long, 7 feet wide, and from 3 to 4 feet in height.

At a locality from 8,500 to 10,000 feet below East Point 895 cubic yards of stone were placed on the sea side of the concrete wall, and 163 cubic yards on the river side as a protection to the wall.

The materials used during the year in the construction of cribs for building up and protecting this jetty were as follows: 5,897 linear feet of 12 by 12 inch timber; 1,458 drift bolts from 18 to 24 inches long and from three-quarters to seven-eighths of an inch in diameter; 68 screw bolts 2 feet long; 838 linear feet of 3 by 12 inch plank; 248 cubic yards of stone, and 4 piles.

Excepting the subsidence which took place, the concrete wall on this jetty remained unchanged during the year, and is still in fair condition. Its average subsidence during the year was two-tenths of a foot, and since its completion in September, 1889, the average subsidence has been forty-one one-hundredths of a foot.

The crib work capping over a portion of this jetty will prove to be but of a tentative character, as the timber contained in it, particularly in the lower courses, is being destroyed by the teredo.

By reference to Chart No. 1 and note thereon the location and character of the work on this jetty and other work hereafter mentioned will be understood.

*Inner East Jetty.*—This work was continued upstream 360 feet during the year, so as to keep pace with the recession of the land to the eastward of the main jetty, whereby that work was being uncovered and exposed to the sea.

Materials were added at other localities which required building up, and a crib 145 feet long, 9 feet wide, and 4 feet high was placed above Dam 23, forming a continuation of the crib work from the outer end of this jetty.

The following materials were used in this work: 5,004 cords of willows, 1,047 cubic yards of stone, 304 piles, 1,247 linear feet of 12 by 12 inch timber, and 304 drift bolts. The work is in good condition.

*Inner West Jetty.*—To this work 1,706 cords of willows and 176 cubic yards of stone were added during the year, and it is also in good condition.

### WING DAMS.

One wing dam, No. 46, was built projecting from the east shore at a point 3,620 feet below East Point. It is 36 feet long and 8 feet wide.

Eleven of the older dams were repaired, some of them requiring new piling at the outer ends to replace those cut off by the teredo, while salt water was in the channel during low river, and 13 had materials added to them.

Such of these dams as it is necessary to maintain, are now in good condition; the following materials were used in them during the year: 64 piles, 871 cords of willows, 186 cubic yards of stone, 415 linear feet of 12 by 12 inch timber, 111 screw bolts, and 4 driftbolts.

### DREDGING.

The dredge boat was kept in commission during the year, and when required, and the weather permitted, dredging was done. The time occupied in actual work amounted to 73 days of 10 hours each, as follows: 51 days in the jetty channel and beyond the ends of the jetties, 6 days in the entrance to South Pass at its head, and 16 in the crossing in Goat Island Reach.

### THE PLANT.

One barge 100 feet long, 22 feet wide, and 5 feet depth of hold, and one flatboat 30 by 16 by 2 feet were built. Five barges, two flatboats, a pile-driver, and derrick boat were repaired, a tool house built, a corrugated iron roof put on carpenter shop and storehouse, and twenty mooring piles driven along the bank of the pass.

## THE FORCE EMPLOYED.

The average force employed during the year, including officers, mechanics, laborers, was 42 in number.

## EXAMINATIONS AND SURVEYS.

The principal results of examinations and surveys made during the year wil found on the charts which accompany this report, and in the tables contained her

A survey in the gulf and just beyond the ends of the jetties was partially c pleted, and then unavoidably abandoned, principally because of the unfavor weather which prevailed, and also on account of the work required by the close tention it was necessary to give to the channel at the head of the passes, and in pass itself.

To obtain satisfactory soundings over this area several continuously calm d are required, and the almost entire absence of such weather has rendered this sea exceptional. Under any other conditions a strong gulf current generally exi and is often opposed to the surface current, so that the lead is carried in one di tion while the launch drifts in the opposite direction, which renders it impossi to get accurate soundings, so that at times in past years I have had to disconti the survey and await more favorable conditions. Then, too, in high river we h to contend with the strong current setting out from the pass, so that on the wh this work may be more satisfactorily done when the river reaches its low stage, which time the favorable conditions will obtain, and the deposit of sediment brou down during high river will have taken place.

## AT THE HEAD OF THE PASSES.

The chart of this survey is No. 4. The survey was made during the month of tober, 1892, while the river was low.

Using section GH, which is 2,120 feet above the upper dam, and comparing t depths with those obtained one year previous, I find that for a distance of 2,200 f from the east shore there has been a shoaling of from 1 to 3 feet, thence 800 feet to the westward the shoaling varies from 3 to 7 feet, thence for 1,050 feet the westward a quite uniform deepening of 4 feet took place, while for the remain of the section there was practically no change.

Using section IJ, which is 250 feet above upper dam, it will be found that fo distance of 1,600 feet from the east shore a quite uniform shoaling of 5 feet is the sult, thence for 1,200 feet the shoaling averages 3 feet, thence for 500 feet there i deepening of 13 feet, thence for 800 feet a deepening varying from 7 to 10 feet, then for 700 feet a shoaling varying from 6 to 10 feet, and for the remainder of the secti the shoaling averages 2 feet.

From the foregoing it will be ascertained that the area which has deepened is the eastward of a point which is 2,600 feet from the west shore, measured on t upper section, and following downwards it extends into Pass à Loutre.

The 26-foot curve below the mattress sill across Pass à Loutre moved to the we ward 950 feet, the current seems forced to the westward and is very strong again the west bank which it is rapidly undermining.

The shoal which appears in the entrance to South Pass, between the beacon light had increased up to the date of the survey, but during the month of March it almo entirely disappeared.

During the same month, large volumes of sand were being deposited at the he of the passes, and gradually moving downward, and generally to the eastward, for ing a large shoal.

The sand was constantly in motion, and the shoal was now one form and then a other, finally disintegrating, forming many smaller shoals, which moved in differe directions, being gradually worn away by the current and eventually disappeari in the deep water of either of the passes.

Much sand had moved into South Pass, and on June 5 a shoal was found to exi between the beacon lights at the entrance, which rendered the channel depth le than the required "navigable depth of 26 feet."

Dredging was done, and finally a wing dam was built to hasten the scouring a channel through this shoal. By this time the quantity of sand coming down ha greatly decreased, the channel began to improve rapidly, and on June 19 it w found to have become restored.

With the exception, therefore, of fourteen days from June 5 to June 18, inclusiv there was a "channel having a navigable depth of 26 feet" through the shoal at th head of South Pass during the year.

### SURVEY OF SOUTH PASS FROM ITS HEAD TO SOUTH PASS LIGHT-HOUSE.

During the month of October, 1892, while the river was at its lowest stage, I completed a survey of South Pass, the charts of which are Nos. 2 and 3, and the following table compiled therefrom gives the depth and width of the channel in different sections.

*Tabulated statement of the depth and width of channel throughout the South Pass of the Mississippi River from East Point to the head of the Passes, given in separate reaches one-fourth of a mile in length, from a survey made in October, 1892.*

| Locality. | | Available depth. | Available width of— | |
|---|---|---|---|---|
| From— | To above East Point. | | 26-foot channel. | 30-foot channel. |
| East Point | ¼ mile | 29.0 | 210 | (*a*) |
| Above East Point— | | | | |
| ¼ mile | ½ mile | 29.9 | 350 | (*b*) |
| ½ mile | ¾ mile | 33.0 | 300 | 200 |
| ¾ mile | 1 mile | 36.0 | 280 | 140 |
| First mile | | 29.0 | 210 | ..... |
| 1 mile | 1¼ miles | 31.3 | 300 | 110 |
| 1¼ miles | 1½ miles | 30.8 | 310 | 130 |
| 1½ miles | 1¾ miles | 30.1 | 410 | 60 |
| 1¾ miles | 2 miles | 30.7 | 430 | 280 |
| Second mile | | 30.1 | 300 | 60 |
| 2 miles | 2¼ miles | 32.4 | 440 | 320 |
| 2¼ miles | 2½ miles | 34.0 | 420 | 360 |
| 2½ miles | 2¾ miles | 35.5 | 440 | 390 |
| 2¾ miles | 3 miles | 32.5 | 430 | 360 |
| Third mile | | 32.4 | 420 | 320 |
| 3 miles | 3¼ miles | 33.0 | 380 | 200 |
| 3¼ miles | 3½ miles | 31.1 | 360 | 120 |
| 3½ miles | 3¾ miles | 31.4 | 360 | 140 |
| 3¾ miles | 4 miles | 33.0 | 360 | 180 |
| Fourth mile | | 31.1 | 360 | 120 |
| 4 miles | 4¼ miles | 33.0 | 400 | 200 |
| 4¼ miles | 4½ miles | 32.0 | 460 | 310 |
| 4½ miles | 4¾ miles | 34.0 | 440 | 250 |
| 4¾ miles | 5 miles | 36.5 | 320 | 220 |
| Fifth mile | | 32.0 | 320 | 200 |
| 5 miles | 5¼ miles | 32.0 | 330 | 120 |
| 5¼ miles | 5½ miles | 28.1 | 390 | (*c*) |
| 5½ miles | 5¾ miles | 28.8 | 390 | (*d*) |
| 5¾ miles | 6 miles | 28.4 | 390 | (*e*) |
| Sixth mile | | 28.1 | 330 | ..... |
| Above East Point— | | | | |
| 6 miles | 6¼ miles | 27.8 | 220 | (*f*) |
| 6¼ miles | 6½ miles | 26.8 | 390 | (*g*) |
| 6½ miles | 6¾ miles | 29.7 | 410 | (*h*) |
| 6¾ miles | 7 miles | 33.4 | 410 | 300 |
| Seventh mile | | 26.8 | 220 | ..... |
| 7 miles | 7¼ miles | 32.0 | 460 | 160 |
| 7¼ miles | 7½ miles | 32.0 | 420 | 230 |
| 7½ miles | 7¾ miles | 35.0 | 390 | 300 |
| 7¾ miles | 8 miles | 34.8 | 340 | 250 |
| Eighth mile | | 32.0 | 340 | 160 |
| 8 miles | 8¼ miles | 32.6 | 360 | 230 |
| 8¼ miles | 8½ miles | 30.8 | 380 | 230 |
| 8½ miles | 8¾ miles | 32.5 | 280 | 190 |
| 8¾ miles | 9 miles | 35.4 | 250 | 180 |
| Ninth mile | | 30.8 | 250 | 180 |
| 9 miles | 9¼ miles | 32.5 | 280 | 150 |
| 9¼ miles | 9½ miles | 28.0 | 360 | (*i*) |
| 9½ miles | 9¾ miles | 32.5 | 360 | 250 |
| 9¾ miles | 10 miles | 46.0 | 350 | 300 |
| Tenth mile | | 28.0 | 280 | ..... |
| 10 miles | 10¼ miles | 35.0 | 340 | 270 |
| 10¼ miles | 10½ miles | 38.0 | 320 | 250 |
| 10½ miles | 10¾ miles | 33.0 | 320 | 265 |
| 10¾ miles | 11 miles | 32.0 | 270 | 160 |
| Eleventh mile | | 32.0 | 270 | 160 |
| 11 miles | 11¼ miles | 40.0 | 900 | 830 |
| 11¼ miles | 11½ miles | 35.0 | 920 | 770 |
| 11½ miles | 11¾ miles | 36.0 | (*) | (*) |
| 11¾ miles | 12 miles | †35 + | (†) | (†) |
| Twelfth mile | | 35.0 | 900 | 770 |

* Very wide.

† In Mississippi River, above the head of the Passes.

*Length of the portion of this reach lacking a central depth of 30 feet.*

| | Feet. |
|---|---|
| (*a*) | 925 |
| (*b*) | 30 |
| (*c*) | 780 |
| (*d*) | 440 |
| (*e*) | 300 |
| (*f*) | 1,320 |
| (*g*) | 1,040 |
| (*h*) | 100 |
| (*i*) | 910 |
| Total | 5,845 |

By reference to the comparative profiles on chart No. 5 it will be seen that above Grand Bayou some sections deepened while others shoaled, while below that bayou a marked deepening took place during the year.

These profiles furnished the most detailed information relative to the changes which have taken place in the pass during the year and since 1875, the general result being a deepening during the year and a decided shoaling since 1875.

In Goat Island Reach, at a locality 1¾ miles below the Head of the Passes lighthouse, a shoaling reduced the depth of water in the channel to less than the required "navigable depth of 26 feet" for a period of twenty-six days from May 27 to June 20, both dates inclusive, also on June 30, and during a portion of this interval, from June 12 to June 18, inclusive, the required channel did not obtain at a locality about one-half a mile below the Head of the Passes light-house.

With the exception of twenty-five days above mentioned, "a navigable depth of 26 feet" was maintained during the year throughout South Pass.

### THE CHANNEL THROUGH THE JETTIES.

The channel through the jetties, and beyond them to deep water in the Gulf is shown on chart No. 1.

The required channel, "26 feet in depth, not less than 200 feet in width at the bottom, and having through it a central depth of 30 feet without regard to width," was maintained during the year by the aid of dredging.

The fluctuations in the depth and width of this channel during the year may be known from the following table, and the profiles on chart No. 5 explain the total change in depth which took place:

*Tabulated statements relative to the available depths and widths of channel through the jetties, in separate reaches of 2,000 feet each, according to surveys made during the fiscal year ending June 30, 1893.*

| Date. | Distances from East Point, in feet. | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 0–2,000. | | | 2,000–4,000. | | | 4,000–6,000. | | |
| | Available depth. | Available width of— | | Available depth. | Available width of— | | Available depth. | Available width of— | |
| | | 26-foot channel. | 30-foot channel. | | 26-foot channel, | 30-foot channel. | | 26-foot channel. | 30-foot channel. |
| 1892. | | | | | | | | | |
| June | 30.4 | 205 | 40 | 32.3 | 340 | 125 | 36.0 | 310 | 240 |
| July | 31.5 | 320 | 100 | 33.0 | 350 | 230 | 32.0 | 310 | 165 |
| August | 31.5 | 260 | 80 | 33.5 | 350 | 280 | 33.8 | 305 | 230 |
| September | 31.2 | 300 | 60 | 32.7 | 330 | 250 | 31.2 | 315 | 190 |
| October | 31.8 | 360 | 80 | 32.5 | 355 | 245 | 31.8 | 300 | 210 |
| November | 31.5 | 300 | 55 | 32.1 | 350 | 250 | 31.5 | 290 | 190 |
| December | 31.0 | 320 | 90 | 31.5 | 330 | 230 | 31.6 | 285 | 180 |
| 1893. | | | | | | | | | |
| January | 31.6 | 340 | 90 | 32.2 | 350 | 240 | 31.3 | 280 | 190 |
| February | 31.6 | 330 | 100 | 31.6 | 330 | 200 | 31.0 | 285 | 125 |
| March | 33.6 | 260 | 150 | 34.6 | 360 | 270 | 33.1 | 310 | 140 |
| April | 33.6 | 300 | 130 | 35.0 | 360 | 290 | 33.6 | 300 | 200 |
| May | 32.0 | 250 | 155 | 34.0 | 380 | 300 | 33.0 | 350 | 220 |
| June | 32.7 | 300 | 170 | 33.0 | 360 | 280 | 33.8 | 330 | 240 |

| Date. | 6,000–8,000. | | | 8,000–10,000. | | | 10,000–12,000. | | |
|---|---|---|---|---|---|---|---|---|---|
| | Available depth. | Available width of— | | Available depth. | Available width of— | | Available depth. | Available width of— | |
| | | 26-foot channel. | 30-foot channel. | | 26-foot channel. | 30-foot channel. | | 26-foot channel. | 30-foot channel. |
| 1892. | | | | | | | | | |
| June | 37.0 | 270 | 215 | 36.6 | 280 | 210 | 33.2 | 280 | 220 |
| July | 35.6 | 260 | 215 | 38.0 | 265 | 210 | 34.2 | 270 | 190 |
| August | 34.6 | 250 | 190 | 34.8 | 270 | 195 | 35.0 | 260 | 190 |
| September | 33.6 | 255 | 180 | 33.7 | 255 | 170 | 33.5 | 255 | 165 |
| October | 31.5 | 235 | 170 | 32.7 | 240 | 150 | 32.3 | 250 | 160 |
| November | 32.0 | 240 | 190 | 33.0 | 240 | 150 | 32.6 | 260 | 145 |
| December | 32.1 | 250 | 190 | 33.5 | 270 | 150 | 33.1 | 265 | 160 |
| 1893. | | | | | | | | | |
| January | 32.1 | 250 | 165 | 32.2 | 250 | 150 | 34.1 | 210 | 140 |
| February | 31.6 | 255 | 150 | 32.7 | 215 | 130 | 34.0 | 250 | 150 |
| March | 30.8 | 280 | 90 | 31.2 | 260 | 80 | 32.4 | 265 | 140 |
| April | 31.6 | 260 | 130 | 32.3 | 250 | 90 | 32.6 | 250 | 100 |
| May | 33.0 | 270 | 185 | 32.5 | 280 | 140 | 32.0 | 275 | 155 |
| June | 30.0 | 260 | 210 | 31.7 | 260 | 120 | 30.5 | 270 | 120 |

Beyond the end of the jetties and on a direct course from there to sea the required channel was maintained during the year, but the channel turning to the eastward, beyond the end of the east jetty, shoaled to such an extent that it is now practically closed.

The following table gives the depths through the jetties from 1875 to the present time:

*Table giving the depths of water through the jetties at various dates.*

| Date. | Distances from East Point, in feet. | | | | | |
|---|---|---|---|---|---|---|
| | 0 to 2,000. | 2,000 to 4,000. | 4,000 to 6,000. | 6,000 to 8,000. | 8,000 to 10,000. | 10,000 to 12,000. |
| 1875—June | 22.5 | 18.7 | 16.7 | 10.2 | 9.7 | 9.2 |
| 1876—May | 23.3 | 20.3 | 22.0 | 21.0 | 17.1 | 15.0 |
| August | 23.5 | 19.6 | 21.0 | 23.5 | 23.0 | 19.8 |
| November | 22.0 | 20.3 | 21.1 | 21.2 | 21.1 | 20.3 |
| 1877—March | 24.1 | 21.1 | 23.2 | 22.0 | 21.2 | 20.5 |
| July | 24.9 | 24.0 | 26.0 | 23.8 | 23.5 | 20.3 |
| October 25 to December 14 | 26.3 | 24.4 | 28.5 | 24.2 | 23.0 | 23.7 |
| 1878—March | 26.0 | 25.9 | 35.5 | 25.4 | 24.3 | 23.0 |
| December | 28.4 | 26.4 | 35.7 | 27.1 | 25.3 | 23.0 |
| 1879—March | 28.6 | 27.5 | 43.4 | 27.0 | 27.0 | 27.0 |
| June | 27.5 | 28.4 | 47.7 | 29.2 | 29.2 | 28.0 |
| July | 30.5 | 30.7 | ......... | 31.0 | 30.7 | 30.5 |
| December | 31.0 | 31.0 | 48.3 | 31.7 | 31.8 | 30.8 |
| 1830—June | 31.0 | 32.5 | 47.8 | 31.4 | 35.1 | 32.0 |
| July | 30.5 | 31.0 | 44.0 | 30.8 | 31.5 | 30.5 |
| August | 30.5 | 30.4 | 46.0 | 32.0 | 32.0 | 30.0 |
| September | 30.7 | 31.0 | 44.4 | 30.6 | 32.0 | 31.5 |
| October | 31.0 | 31.5 | 41.0 | 30.3 | 31.0 | 30.5 |
| November | 30.6 | 31.0 | 40.3 | 30.8 | 30.9 | 30.3 |
| December | 30.9 | 30.6 | 43.0 | 30.8 | 31.0 | 30.3 |
| 1881—January | 30.5 | 30.4 | 41.9 | 33.8 | 30.7 | 30.3 |
| February | 30.4 | 30.2 | 41.6 | 32.0 | 31.0 | 30.0 |
| March | 31.5 | 31.2 | 41.3 | 32.0 | 32.0 | 30.5 |
| April | 30.4 | 30.0 | 48.0 | 33.0 | 33.0 | 30.5 |
| May | 30.2 | 30.5 | 42.7 | 32.6 | 30.5 | 31.2 |
| June | 30.0 | 30.5 | 43.8 | 32.0 | 31.7 | 31.7 |
| July | 31.0 | 32.0 | 42.5 | 33.5 | 33.0 | 32.0 |
| August | 30.1 | 32.0 | 37.6 | 32.0 | 31.0 | 30.2 |
| October | 30.2 | 30.3 | 38.3 | 31.4 | 31.2 | 30.3 |
| November | 30.8 | 31.8 | 39.2 | 30.4 | 30.0 | 30.1 |
| December | 30.2 | 32.8 | 39.4 | 30.8 | 30.2 | 30.0 |
| 1882—January | 30.5 | 30.4 | 41.3 | 31.1 | 30.2 | 30.7 |
| February | 31.8 | 36.0 | 39.7 | 30.5 | 30.8 | 30.2 |
| March | 31.2 | 30.6 | 39.2 | 30.8 | 31.6 | 32.5 |
| April | 31.7 | 32.6 | 39.6 | 30.5 | 30.3 | 33.0 |
| May | 30.5 | 32.5 | 39.4 | 31.0 | 31.3 | 31.0 |
| June | 30.8 | 35.5 | 39.0 | 31.2 | 31.3 | 31.0 |
| July | 30.0 | 32.7 | 38.7 | 30.6 | 31.3 | 31.5 |
| August | 30.3 | 32.2 | 38.1 | 31.8 | 31.8 | 30.5 |
| September | 30.1 | 31.5 | 38.3 | 31.9 | 30.8 | 30.5 |
| October | 30.0 | 31.0 | 37.1 | 31.0 | 31.4 | 31.2 |
| November | 30.0 | 32.0 | 38.1 | 21.5 | 31.2 | 31.2 |
| December | 31.0 | 31.0 | 37.0 | 31.2 | 31.0 | 30.4 |
| 1883—January | 31.0 | 31.0 | 35.2 | 30.2 | 30.1 | 30.1 |
| February | 31.2 | 31.2 | 36.0 | 30.5 | 30.0 | 30.1 |
| March | 32.3 | 32.6 | 45.7 | 31.5 | 30.3 | 30.3 |
| April | 33.7 | 35.0 | 44.0 | 32.2 | 30.0 | 39.0 |
| May | 33.2 | 36.3 | 46.0 | 32.3 | 30.3 | 32.4 |
| June | 32.5 | 34.2 | 45.0 | 33.4 | 31.0 | 33.0 |
| July | 33.8 | 34.9 | 44.0 | 32.0 | 31.5 | 31.8 |
| August | 32.1 | 38.2 | 48.0 | 33.4 | 33.4 | 32.2 |
| September | 33.4 | 34.3 | 46.0 | 32.3 | 32.3 | 30.6 |
| October | 32.7 | 34.1 | 41.5 | 32.0 | 32.0 | 30.5 |
| November | 31.0 | 33.8 | 43.8 | 34.5 | 31.5 | 31.0 |
| December | 30.5 | 32.6 | 43.0 | 31.6 | 31.6 | 30.2 |
| 1884—January | 31.2 | 32.2 | 39.2 | 32.7 | 31.8 | 30.3 |
| February | 32.0 | 31.5 | 41.3 | 31.6 | 31.0 | 30.7 |
| March | 35.7 | 39.5 | 41.6 | 34.0 | 33.8 | 38.7 |
| April | 35.3 | 37.3 | 41.5 | 31.7 | 32.7 | 35.4 |
| May | 34.9 | 35.8 | 42.3 | 34.3 | 35.1 | 33.0 |
| June | 35.0 | 35.8 | 41.1 | 34.0 | 35.0 | 35.0 |
| August | 31.9 | 35.8 | 41.9 | 33.9 | 35.0 | 32.0 |
| September | 32.0 | 34.0 | 39.0 | 33.1 | 33.7 | 33.5 |
| October | 31.1 | 33.4 | 38.6 | 32.6 | 32.6 | 32.5 |
| November | 32.8 | 32.8 | 37.2 | 32.2 | 32.4 | 30.8 |
| December | 31.6 | 32.6 | 37.1 | 31.1 | 31.5 | 31,4 |
| 1885—January | 36.7 | 36.4 | 36.9 | 33.1 | 34.6 | 32.8 |
| February | 41.7 | 36.3 | 35.7 | 30.5 | 34.1 | 36.2 |
| March | 35.5 | 36.0 | 36.1 | 31.0 | 31.7 | 35.7 |
| April | 36.0 | 35.5 | 37.0 | 32.0 | 32.6 | 32.0 |

*Table giving the depths of water through the jetties at various dates*—Continued.

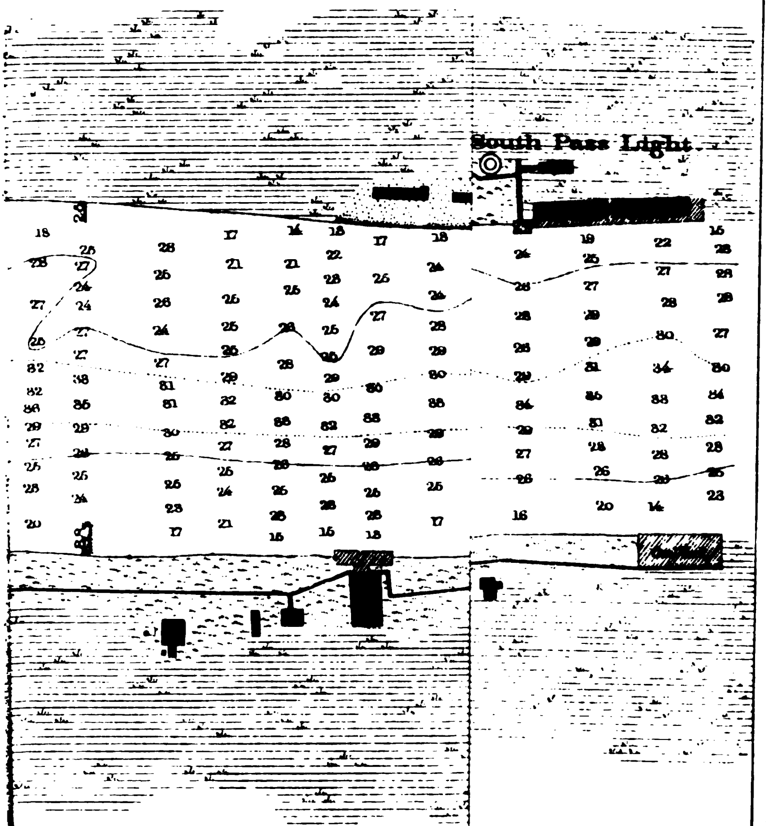
| Date. | Distances from East Point, in feet. | | | | | |
|---|---|---|---|---|---|---|
| | 0 to 2,000. | 2,000 to 4,000. | 4,000 to 6,000. | 6,000 to 8,000. | 8,000 to 10,000. | 10,000 to 12,000. |
| 1885—May | 36.7 | 35.0 | 35.6 | 31.5 | 33.5 | 31.5 |
| June | 34.7 | 33.7 | 35.7 | 32.8 | 32.8 | 31.3 |
| July | 30.3 | 33.1 | 36.5 | 33.7 | 33.6 | 31.0 |
| August | 36.5 | 35.6 | 37.6 | 33.0 | 32.6 | 31.0 |
| September | 35.3 | 33.3 | 35.2 | 32.2 | 30.7 | 31.7 |
| October | 33.8 | 33.7 | 35.8 | 31.3 | 30.4 | 30.4 |
| November | 32.7 | 32.8 | 35.1 | 30.8 | 30.6 | 30.1 |
| December | 33.0 | 32.2 | 34.2 | 30.9 | 30.5 | 30.6 |
| 1886—January | 33.6 | 32.5 | 33.0 | 30.2 | 30.2 | 28.0 |
| February | 32.8 | 32.8 | 34.1 | 31.3 | 30.9 | 30.0 |
| March | 32.8 | 35.8 | 34.0 | 35.0 | 33.1 | 32.0 |
| April | 35.4 | 34.5 | 34.5 | 33.7 | 33.7 | 31.0 |
| May | 35.9 | 35.6 | 34.2 | 31.0 | 36.0 | 34.4 |
| June | 38.2 | 35.2 | 33.4 | 33.2 | 34.5 | 36.5 |
| July | 36.7 | 36.7 | 36.2 | 32.8 | 32.7 | 37.0 |
| August | 35.0 | 36.3 | 35.7 | 34.8 | 33.8 | 34.7 |
| September | 34.5 | 35.6 | 34.6 | 33.7 | 33.6 | 33.0 |
| October | 35.0 | 36.2 | 34.4 | 33.0 | 34.1 | 33.0 |
| November | 34.5 | 35.6 | 34.8 | 32.9 | 33.0 | 33.5 |
| December | 34.0 | 35.0 | 35.3 | 33.6 | 32.6 | 33.0 |
| 1887—January | 33.6 | 34.0 | 33.3 | 32.3 | 32.7 | 33.4 |
| February | 36.4 | 34.4 | 35.4 | 31.3 | 34.1 | 32.4 |
| March | 35.5 | 35.5 | 32.6 | 35.5 | 35.5 | 33.8 |
| April | 38.8 | 37.0 | 33.7 | 31.0 | 34.8 | 35.5 |
| May | 39.4 | 35.3 | 37.1 | 31.2 | 34.2 | 38.1 |
| June | 39.0 | 35.4 | 37.5 | 32.3 | 34.1 | 35.2 |
| July | 39.0 | 36.4 | 35.8 | 34.0 | 32.0 | 34.0 |
| August | 35.7 | 34.6 | 34.7 | 33.6 | 31.6 | 32.7 |
| September | 36.0 | 34.0 | 35.0 | 35.0 | 32.7 | 32.2 |
| October | 36.2 | 34.2 | 34.3 | 32.1 | 32.2 | 31.8 |
| November | 35.9 | 32.9 | 33.8 | 30.7 | 31.8 | 31.2 |
| December | 34.7 | 32.7 | 33.9 | 30.9 | 31.7 | 31.8 |
| 1888—January | 35.6 | 32.5 | 33.7 | 30.5 | 31.5 | 32.2 |
| February | 34.3 | 32.4 | 32.5 | 31.0 | 31.0 | 32.0 |
| March | 34.0 | 33.0 | 32.6 | 30.5 | 31.3 | 30.9 |
| April | 36.3 | 34.8 | 33.8 | 31.0 | 35.0 | 31.4 |
| May | 35.2 | 35.2 | 34.3 | 31.6 | 33.6 | 33.0 |
| June | 32.0 | 33.0 | 33.0 | 31.4 | 35.5 | 33.2 |
| July | 34.2 | 34.0 | 33.8 | 31.0 | 31.9 | 33.6 |
| August | 33.7 | 33.7 | 33.7 | 31.2 | 31.2 | 33.2 |
| September | 32.7 | 32.7 | 32.8 | 30.8 | 31.0 | 32.0 |
| October | 33.3 | 33.3 | 32.3 | 30.6 | 30.4 | 30.4 |
| November | 31.8 | 32.8 | 31.7 | 30.6 | 30.6 | 30.8 |
| December | 31.4 | 32.4 | 31.6 | 30.3 | *29.2 | 30.7 |
| 1889—January | 31.0 | 31.3 | 30.6 | 30.3 | 31.0 | 30.9 |
| February | 32.4 | 32.5 | 31.8 | 32.8 | 31.0 | 32.5 |
| March | 30.2 | 32.2 | 30.4 | 32.3 | 31.8 | 31.6 |
| April | 30.8 | 32.1 | 31.2 | 32.8 | 31.8 | 30.6 |
| May | 30.8 | 32.0 | 30.7 | 32.6 | 31.2 | 30.8 |
| June | 30.4 | 32.2 | 31.3 | 31.5 | 31.0 | 30.8 |
| July | 30.3 | 31.0 | 31.0 | 32.4 | 31.3 | 31.0 |
| August | 31.7 | 31.4 | 31.5 | 31.6 | 31.4 | 31.0 |
| September | 30.9 | 31.3 | 31.2 | 31.0 | 31.1 | .......... |
| October | 31.6 | 31.0 | 31.2 | 31.0 | 31.7 | †29.6 |
| November | 31.0 | 31.2 | 31.2 | 31.0 | 31.3 | 31.4 |
| December | 30.8 | 31.0 | 31.2 | 31.0 | 31.7 | 31.2 |
| 1890—January | 30.8 | 30.8 | 31.2 | 30.6 | 31.0 | 31.0 |
| February | 31.7 | 30.7 | 31.5 | 32.6 | 34.4 | 33.0 |
| March | 36.4 | 33.2 | 34.0 | 34.0 | 34.0 | 33.6 |
| April | 33.4 | 36.0 | 35.0 | 35.0 | 38.7 | 34.5 |
| May | 32.0 | 34.0 | 34.0 | 36.0 | 39.0 | 34.0 |
| June | 32.0 | 33.5 | 33.0 | 34.0 | 39.8 | 35.0 |
| July | 32.4 | 33.4 | 34.0 | 34.0 | 39.0 | 37.0 |
| August | 32.0 | 33.0 | 33.0 | 32.7 | 35.0 | 34.0 |
| September | 30.5 | 31.4 | 33.0 | 33.0 | 35.0 | 33.0 |
| October | 32.0 | 31.0 | 31.0 | 30.5 | 34.0 | 32.8 |
| November | 30.6 | 31.2 | 30.6 | 30.6 | 34.0 | 33.0 |
| December | 31.5 | 31.2 | 31.0 | 30.7 | 32.3 | 33.5 |
| 1891—January | 31.0 | 31.0 | 31.2 | 32.2 | 32.3 | 32.5 |
| February | 31.7 | 31.0 | 31.4 | 32.5 | 35.2 | 32.7 |
| March | 32.0 | 34. | 36.4 | 37.5 | 36.0 | 34.6 |
| April | ‡30.5 | 32.0 | 36.5 | 39.0 | 36.4 | 34.2 |
| May | ‡30.3 | ‡32.0 | 32.0 | 35.0 | 36.0 | 34.0 |
| June | 33.0 | 31.1 | 32.0 | 34.7 | 37.0 | 35.0 |
| July | 31.4 | 30.4 | 30.4 | 33.3 | 35.8 | 34.8 |
| August | 31.0 | 31.0 | 31.0 | 32.3 | 32.9 | 31.4 |

* From December 28, 1888, to January 4, 1889, inclusive.

† From October 1 to October 5, inclusive.

‡ Depth less than 30 feet from April 25 to May 6, both dates inclusive, and varied from 27.5 to 29.4 feet.

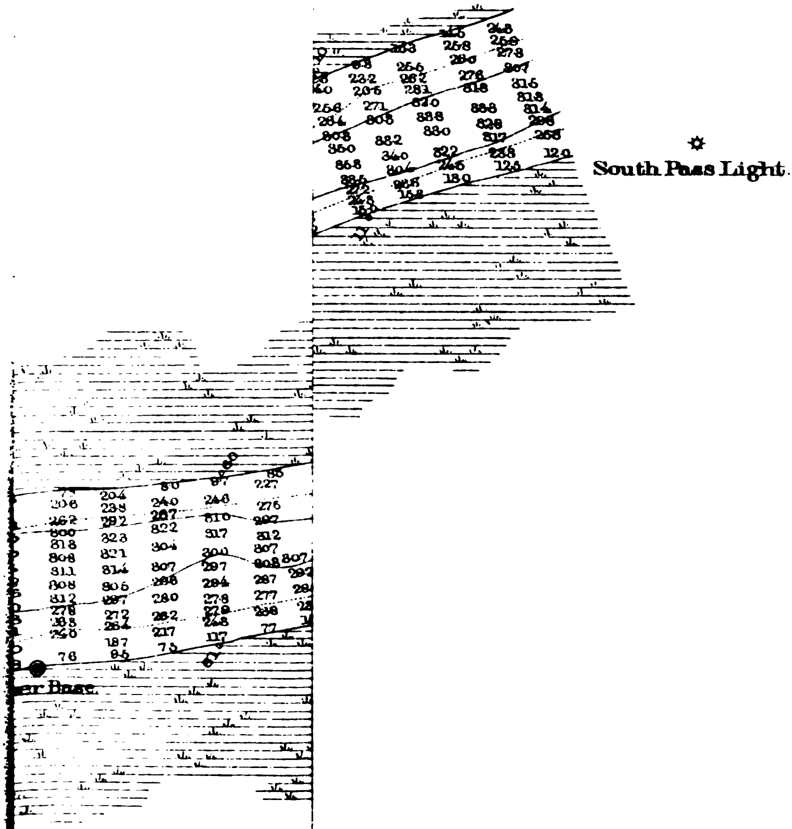
No. 1.



To accompany annual rep. June 30, 1898.

James B. Quinn,
Major Corps of Engrs, U.S.A.

Eng 98

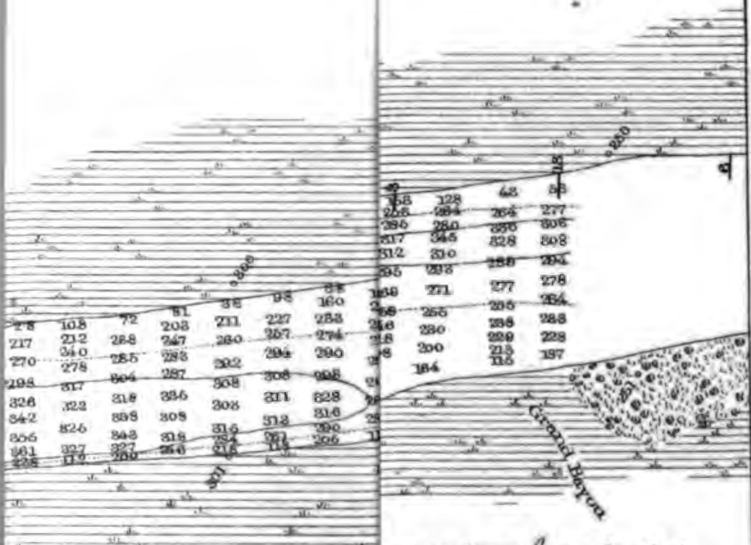


ual report for year ending June 30, 1893.

James B. Quinn

Major, Corps of Engineers.

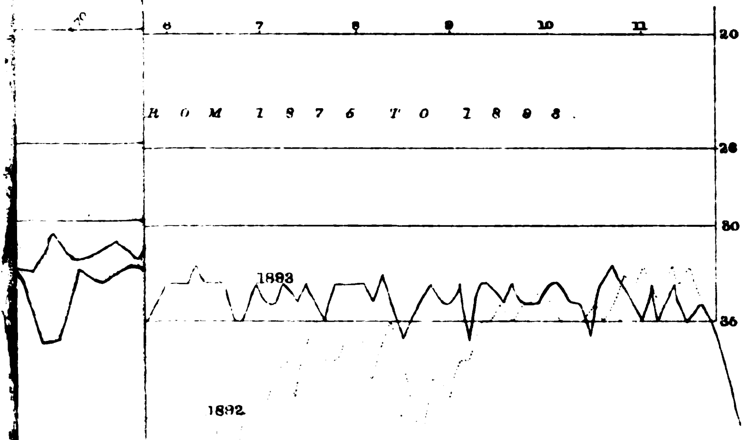
U.S. Army.



ear ending June 30, 1893.

ame B. Quinn

Major, Corps of Engineers,
U. S. Army.



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th annual report for year ending June 30, 1893.

James B. Quinn

Major, Corps of Engineers

U. S. Army.

*Table giving the depths of water through the jetties at various dates*—Continued.

| Date. | Distances from East Point, in feet. | | | | | |
|---|---|---|---|---|---|---|
| | 0 to 2,000. | 2,000 to 4,000. | 4,000 to 6,000. | 6,000 to 8,000. | 8,000 to 10,000. | 10,000 to 12,000. |
| 1891—September | 30.6 | 30.6 | 30.7 | 31.0 | 31.5 | .......... |
| October | 31.0 | 30.8 | 30.8 | 31.2 | 31.2 | 30.7 |
| November | 31.2 | 31.0 | 31.3 | 31.2 | 31.1 | 30.6 |
| December | 30.1 | 30.3 | 30.6 | 31.4 | 31.3 | 32.0 |
| 1892—January | 31.3 | 31.6 | 31.3 | 31.3 | 31.8 | 32.2 |
| February | 30.5 | 30.8 | 30.8 | 31.0 | 31.1 | 31.7 |
| March | 30.8 | 30.7 | 31.4 | 31.7 | 31.2 | 31.0 |
| April | 32.0 | 32.0 | 33.7 | 32.0 | 30.5 | 30.6 |
| May | *28.1 | *29.6 | 38.0 | 35.0 | 33.0 | 32.0 |
| June | *30.4 | 32.3 | 36.0 | 37.0 | 36.6 | 33.2 |
| July | 31.5 | 33.0 | 32.0 | 35.6 | 38.0 | 34.2 |
| August | 31.5 | 33.5 | 33.8 | 34.6 | 34.8 | 35.0 |
| September | 31.2 | 32.7 | 31.2 | 33.6 | 33.7 | 33.5 |
| October | 31.8 | 32.5 | 31.8 | 31.5 | 32.7 | 32.3 |
| November | 31.5 | 32.1 | 31.5 | 32.0 | 33,0 | 32.6 |
| December | 31.0 | 31.5 | 31.6 | 32.1 | 33.5 | 33.1 |
| 1893—January | 31.6 | 32.2 | 31.3 | 32.1 | 32.2 | 34.1 |
| February | 31.6 | 31.6 | 31.0 | 31.6 | 32.7 | 34.0 |
| March | 33.6 | 34.6 | 33.1 | 30.8 | 31.2 | 32.4 |
| April | 33.6 | 35.0 | 33.6 | 31.6 | 32.3 | 32.6 |
| May | 32.0 | 34.0 | 33.0 | 33.0 | 32.5 | 32.0 |
| June | 32.7 | 33.0 | 33.8 | 36.0 | 31.7 | 30.5 |

* Depth less than 30 feet from May 20 to June 20, both dates inclusive, and varied from 28.1 to 29.6 feet.

### THE NAVIGATION OF THE CHANNEL.

During the months of April, May and June I reported the grounding of eleven steamers, two at the Head of the Passes, one ran to the westward of the west beacon and grounded in Southwest Pass, one in the entrance to South Pass at it head, one at the turn below the Head of the Passes light-house, five at the crossing in Goat Island Reach, and one 900 feet beyond the sea ends of the jetties. They were drawing from 22 to 25 feet.

In five cases the grounding might easily have been avoided; in the other cases the accidents were caused by the vessels striking temporary lumps of sand which were forming here and there with such frequency that it may have been difficult to avoid them. Vessels remained on these lumps but a short time, however, when they would cut downward and to the eastward, and finally "bring up" against the east bank, where they would be held by the strong current until they were pulled off by tugs.

Assistance from tugs was required in five cases, and the greatest delay to the vessel in any case was forty-five hours. This detention the steamship *Gerona* experienced, but her grounding could in no sense be attributable to the nonexistence of a channel sufficient for her accommodation, for it was proven that a most excellent channel did exist.

From time to time I have learned that steamers have touched bottom, or have stopped for a short time in the vicinity of the entrance to South Pass at its head, but as no authentic information could be obtained as to the cause or locality of these mishaps, and as they caused the vessels no detention, it would seem quite evident that a sufficient channel to float them did exist in close proximity to where they touched or stopped.

### CONCLUSION.

In closing this report I desire to acknowledge the faithful and efficient assistance rendered by Recorder G. W. Lawes.

Very respectfully, your obedient servant,

C. DONOVAN,
*Assistant Engineer.*

Maj. JAMES B. QUINN,
*Corps of Engineers, U. S. A.*

# APPENDIX S.

## MPROVEMENT OF RIVERS AND HARBORS IN SOUTHERN LOUISIANA AND EASTERN TEXAS.

### *EPORT OF MAJ. JAMES B. QUINN, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1893, WITH OTHER DOCUMENTS RELATING TO THE WORKS.*

#### IMPROVEMENTS.

1. Chefuncte River and Bogue Falia, Louisiana.
2. Tickfaw River and its tributaries, Louisiana.
3. Amite River and Bayou Manchac, Louisiana.
4. Bayou Lafourche, Louisiana.
5. Bayou Terrebonne, Louisiana.
6. Bayou Plaquemine, Grand River, and Pigeon bayous, Louisiana.
7. Bayou Courtableau, Louisiana.
8. Bayou Teche, Louisiana.
9. Channel, bay, and passes of Bayou Vermillion, Louisiana.
10. Mermentau River and tributaries, Louisiana.
11. Mouth and passes of Calcasieu River, Louisiana.
12. Harbor of Sabine Pass, Tex.
13. Sabine River, Texas.
14. Neches River, Texas.
15. Removing sunken vessels or craft obstructing or endangering navigation.

#### EXAMINATIONS.

16. Homochitto River, Mississippi.
17. Harbor of refuge on Lake Pontchartrain, Louisiana.
18. Connection of bayous Black and Terrebonne between Southdown Plantation and Houma, La.
19. Sabine River from Sudduths Bluff, Texas, to Logansport, La.
20. Channel through Sabine Lake from Sabine Pass to mouths of Sabine and Neches rivers, Texas.
21. Neches River, Texas, from its mouth to Shooks Bluff.

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OFFICE UNITED STATES ENGINEER,
*New Orleans, La., July 7, 1893.*

GENERAL: I have the honor to transmit herewith annual reports * * * upon works of river and harbor improvement at present in my charge for the fiscal year ending June 30, 1893.

* * * * * * *

Very respectfully, your obedient servant,

JAMES B. QUINN,
*Major, Corps of Engineers.*

Brig. Gen. THOMAS L. CASEY,
*Chief of Engineers, U. S. A.*

## S 1.

## IMPROVEMENT OF CHEFUNCTE (TCHEFUNCTE) RIVER AND I FALIA, LOUISIANA.

The project for the improvement of this river was adopted ir
and contemplated the removal of obstructions in the channel, sı
snags, logs, and overhanging trees, and the dredging of the bar
river's mouth.

With the two appropriations made in 1881 and 1882 of $1,500
the obstructions below Covington were removed, and part of the
pended balance was used for the construction of a working pla
improving the bar at the mouth and part for the construction
feet of breakwater.

August 5, 1886, Congress made an appropriation of $2,500 fo
work, and in 1887 channels were cut through the bars between C
ton and Old Landing 5 feet deep and 30 to 60 feet wide, giving
navigation for schooners between these places.

The original estimated cost of improving this river was $5,46
greater portion of which was for dredging the bar at its mouth.

It was thought, however, that a dredged channel over this ba
not be maintained without protecting works, which would cost c
erably more than the dredging. Maj. Stickney, who had charge o
work, caused a reëxamination to be made in 1884, and in his rep
the Annual Report of the Chief of Engineers for 1884, Vol. II, p.
he reports the river in good order, except the bar at its mouth
suggests as a method of improving this to build a jetty or break
2,500 feet long across the bar into the comparatively deep wa
Lake Pontchartrain, and then to dredge the channel through th
in the hope that the jetty would prevent, or at all events greatl
tard, the refilling of the cut with sand.

Under the appropriation of $1,000 made September 19, 1890, the
of removing obstructions in the channel was commenced in Oct
1891, using the snagging plant which had shortly before ceased o
tions on the Tickfaw River. This plant consists of a quarter bo
the accommodation of the working party, and a flat supplied w
derrick and steam-hoisting engine for lifting out snags, and small b
tools, etc., ordinarily used for this class of work.

Snags, logs, and impending trees were removed from the chan
the river from Madisonville to Old Landing, and from the latter
to Covington, on the Bogue Falia, as far as the funds on hand w
permit. The principal obstructions removed from the channel d
the year were: 161 snags, 82 overhanging trees, 61 landslide tre
stumps, 44 logs, and 29 tree tops. The work was discontinued No
ber 30, 1891.

In 1892 an appropriation of $1,000 was made for maintenance.
from making extensive repairs to the snagging plant used on th
provement of these streams, no work was done during the year.

The total amount expended on the improvement to June 30,
was $6,758.74.

The river now has a navigable depth of 5 feet to Old Landing,
from there to Covington the Bogue Falia is navigable for the lig
draft schooners.

About $1,000 will be required each year to keep the river and b
free of obstructions.

*bstract of appropriations for improving Chefuncte (Tchefuncte) River and Bogue Falia, Louisiana.*

| | |
|---|---|
| y act of Congress— | |
| Approved March 3, 1881 | $1,500 |
| Passed August 2, 1882 | 1,500 |
| y act of Congress approved— | |
| August 5, 1886 | 2,500 |
| September 19, 1890 | 1,000 |
| July 13, 1892 | 1,000 |
| Total | 7,500 |

## *Money statement.*

| | |
|---|---|
| uly 1, 1892, balance unexpended | $210.74 |
| mount appropriated by act approved July 13, 1892 | 1,000.00 |
| | 1,210.74 |
| une 30, 1893, amount expended during fiscal year | 469.48 |
| uly 1, 1893, balance unexpended | 741.26 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895<br>Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893. | 1,000.00 |

### COMMERCIAL STATISTICS.

[From June 1, 1892, to May 31, 1893.]

| | |
|---|---|
| Number of steamers | 5 |
| Number of trips | 541 |
| Tonnage | 100,343 |
| Number of barges | 2 |
| Number of trips | 15 |
| Tonnage | 2,925 |
| Number of schooners | 46 |
| Number of trips | 407 |
| Tonnage | 24,420 |
| Total number of vessels | 53 |
| Total number of trips | 963 |
| Total tonnage | 127,688 |

Draft of largest steamer: Light, 5½ feet; loaded, 6½ feet. The entrance is crooked and difficult to enter, and the bar at the mouth has shoaled to about 5 feet.

*Receipts and shipments for two years.*

| Articles. | Year ending May 31, 1892. | | Year ending May 31, 1893. | |
|---|---|---|---|---|
| | Tons. | Value. | Tons. | Value. |
| *Shipments.* | | | | |
| Lumber, shingles, and laths | 16,284 | $109,726 | 8,314 | $120,200 |
| Staves | 292 | 234 | | |
| Brick | 4,540 | 14,528 | 4,405 | 16,571 |
| Sand | 11,566 | 12,845 | 11,776 | 15,702 |
| Wood | 4,475 | 13,715 | 234 | 410 |
| Charcoal | 204 | 272 | | |
| Cotton | 597 | 89,582 | 219 | 36,770 |
| Rice | 276 | 7,745 | 1,103 | 27,496 |
| Miscellaneous | 270 | 4,699 | 100 | 5,000 |
| Sheep, cattle, and horses | | | 101 | 7,386 |
| Tar and rosin | | | 124 | 2,730 |
| Syrup | | | 138 | 4,631 |
| Pecans | | | 8 | 1,488 |
| Moss | | | 8 | 296 |
| Wool | | | 4 | 940 |
| *Receipts.* | | | | |
| Estimated at | 11,550 | 101,338 | 8,750 | 187,500 |
| Total | 50,054 | 354,684 | 30,284 | 429,126 |
| Increase over previous year | | | | 74,442 |

*Comparative statement of receipts and shipments for four years.*

| Year ending May 31— | Tons. | V |
|---|---|---|
| 1890 | 27,803 | $ |
| 1891 | 45,521 | |
| 1892 | 50,054 | |
| 1893 | 30,284 | |

## S 2.

## IMPROVEMENT OF TICKFAW RIVER AND ITS TRIBUTARIES, LOUISI

This work was commmenced in 1879 by an examination authorize Congress. The estimated cost of the improvement was $10,230, the project was to clean out this stream as well as its navigable t taries, the Natalbany, Blood, and Pontchatoula rivers, by remo obstructions to navigation such as snags, logs, stumps, and overh ing trees.

In 1881 $2,000 was appropriated with which to commence work. work under this appropriation was done by contract in 1882, and miles of the Tickfaw was cleaned out.

In 1882 Congress appropriated $2,000 more. This was expen partly in building plant, and the work of cleaning out the stream done with this plant and hired labor. The result was a good navi ble channel 9 miles above the previous head of navigation on the Ti faw.

In 1886 an appropriation of $2,000 was made, the funds to be u for cleaning out the navigable branches of the Tickfaw. In the lat part of 1886 and early part of 1887 work was resumed with the G ernment plant and hired labor, and the branches cleared to the h of navigation.

In 1888 an appropriation of $1,000 was made for improving the Ti faw and its navigable tributaries. The latter being in good conditi the snagging plant commenced work on the river itself in May, 1889, moving the obstructions that had re-formed since 1887, and worked stream to within 1 mile of the Chapman Place, where operations ceas

In 1890 $1,000 was appropriated for continuing the improveme In September, 1891, work was commenced with the Government sn ging plant and hired labor. The obstructions which had re-form since 1889, such as snags, logs, overhanging trees, etc., were remov from the Tickfaw, Natalbany, and Blood rivers, the latter being clear to the head of navigation. About 39 miles of channel had been i proved when work ceased October 12, 1891.

On July 13, 1892, an appropriation of $1,000 was made for mai tenance. The plant, which had shortly before been used on the Ami River, was towed to the Tickfaw, and work was commenced at t mouth of the river on December 20, 1892, and was carried on upstrea resulting in the improvement of 30 miles of channel by the removal 120 logs, 96 snags, 89 overhanging trees, and 63 landslide trees, a the deadening of 14 trees. Operations were discontinued January 2 1893, and the plant was laid up at Springfield, La., and placed charge of a watchman.

Extensive repairs to the snagging plant were completed in Nove ber, 1892. This plant consists of a quarter boat for the working cre a flat supplied with a derrick and steam hoisting engine for pullin out snags, and small boats, tools, etc., ordinarily used for this kind work.

The improvement is not permanent, as logs and snags find their way into the channel, which require removal from time to time. It is estimated that $1,000 will be required annually to keep the navigable channel in condition.

The total amount expended on the improvement of these streams to June 30, 1893, was $8,796.30.

*Abstract of appropriations for improving Tickfaw River and its tributaries, Louisiana.*

| By act of Congress— | |
|---|---|
| Approved March 3, 1881 | $2,000 |
| Passed August 2, 1882 | 2,000 |
| Approved August 5, 1886 | 2,000 |
| Of August 11, 1888 | 1,000 |
| Approved September 19, 1890 | 1,000 |
| Approved July 13, 1892 | 1,000 |
| Total | 9,000 |

*Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $222.04 |
| Amount appropriated by act approved July 13, 1892 | 1,000.00 |
| | 1,222.04 |
| June 30, 1893, amount expended during fiscal year | 1,018.34 |
| July 1, 1893, balance unexpended | 203.70 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895<br>Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893. | 1,000.00 |

COMMERCIAL STATISTICS.

[From June 1, 1892, to May 31, 1893.]

| | |
|---|---|
| Number of steamers | 5 |
| Number of trips | 83 |
| Tonnage | 8,943 |
| Schooners | 47 |
| Number of trips | 138 |
| Tonnage | 8,280 |
| Total number of vessels | 53 |
| Total number of trips | 221 |
| Total tonnage | 17,223 |

*Comparative statement of receipts and shipments for two years.*

| Articles. | Year ending May 31, 1892. | | Year ending May 31, 1893. | |
|---|---|---|---|---|
| | Tons. | Value. | Tons. | Value. |
| *Shipments.* | | | | |
| Wood | 1,200 | $8,440 | 3,748 | $5,355 |
| Lumber | 6,792 | 42,770 | 8,314 | 113,020 |
| Staves | 30 | 630 | | |
| Brick | 537 | 1,720 | 845 | 4,573 |
| Cotton | 121 | 21,975 | 53 | 6,857 |
| Miscellaneous | 95 | 3,581 | 34 | 1,701 |
| Total | 8,775 | 79,116 | 12,990 | 131,506 |
| *Receipts.* | | | | |
| Estimated values of sundry merchandise taken to the Tickfaw River | 2,632 | 23,000 | 1,000 | 38,137 |
| Total | 11,407 | 102,116 | 13,990 | 169,643 |
| Increase over previous year | | | 2,583 | 67,527 |

S 3.

## IMPROVEMENT OF AMITE RIVER AND BAYOU MANCHAC, LOUISIA

The original project for the improvement of this river was adopte 1880, which contemplated a channel 5 feet in depth as far upstrea appropriations would permit, the main part of the work to be above the mouth of the Bayou Manchac.

In 1883, owing to the unsatisfactory manner of doing the work contract, the project was amended so as to provide for the remov obstructions below the Manchac by the Government plant and h labor, and resulted in a satisfactory improvement of about 8 mile the river.

In 1886, under an appropriation of $2,000, work with Governm plant and hired labor was resumed, and the logs and snags removed f about 5 miles of river below the mouth of the Bayou Manchac, leav the Amite River in good navigable condition.

In 1888, $5,000 was appropriated with the stipulation that half of sum might be used in improving Bayou Manchac, and in Novem 1888, work with the Government plant and hired labor was commen in this bayou, working up from its mouth to Hereford Landing, leav the Manchac in good condition up to that point. The plant was t taken back to the Amite River, and from it removed the snags, lo and impending trees which obstructed the channel.

In 1890, $3,800 was appropriated for the completion of the old proj the money, however, to be applied to the Amite or Manchac in s proportions as the engineers might deem best. Work was resumed October, 1890, with the Government plant at Hope Villa, on the Manch and the bayou cleaned up for a distance of about 3 miles, when the pl turned back, and, commencing at Wards Creek, worked downstre to the Amite River.

Snags, logs, and impending trees were removed from the Bay Manchac between its mouth and Hope Villa, and from the river tween its mouth and the junction with Bayou Manchac.

In 1892, $2,500 was appropriated for maintenance, $1,000 of whi is to be used to construct a turning basin for boats at or near t mouth of Wards Creek on Bayou Manchac. As the dredging of a tu ing basin at this place would cost more than the sum stated, my reco mendation that this amount be held for further increase was approv

Authority was obtained for repairing the snagging plant. The d rick and quarter boats were hauled out on ways and supplied with n decks, ends, and roofs, with sheet planking on the sides, and the hu thoroughly calked. The repairs were completed in November, 18 and preparation made for resuming operations. This plant consists a quarter boat for the working party, a derrick boat with steam hoi ing engine for removing obstructions, and small boats, tools, etc., or narily used for this class of work.

Work was commenced November 17, 1892, under the appropriati of that year, at Wards Creek on Bayou Manchac, and was carried to Port Vincent on the Amite River, improving about 20 miles channel by the removal of 57 snags, 57 floating and sunken logs, stumps, 29 overhanging trees, 28 sunken trees, and 9 clusters of brus and the deadening of 165 trees. The work was discontinued Dece ber 15, 1892, and the plant towed to the Tickfaw River for work that stream.

Stumps and logs are continually getting into the channel, formin snags and obstructions, and therefore the improvement is not perm nent. About $2,500 will be required annually to keep these streams in navigable condition. About $2,000 will be required, in addition to the $1,000 now available, for constructing the turning basin for boats at or near the mouth of Wards Creek on Bayou Manchac.

The amount expended on the improvement of these streams to June 30, 1893, was $25,044.

*Abstract of appropriations for improving Amite River and Bayou Manchac, Louisiana.*

| | |
|---|---|
| By act of Congress approved— | |
| June 14, 1880 | $8,000 |
| March 3, 1881 | 5,000 |
| August 5, 1886 | 2,000 |
| By act of Congress of August 11, 1888 | 5,000 |
| By act of Congress approved— | |
| September 19, 1890 | 3,800 |
| July 13, 1892 | 2,500 |
| Total | $26,300 |

*Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $171.85 |
| Amount appropriated by act approved July 13, 1892 | 2,500.00 |
| | 2,671.85 |
| June 30, 1893, amount expended during fiscal year | 1,415.85 |
| July 1, 1893, balance unexpended | 1,256.00 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893. | 4,500.00 |

COMMERCIAL STATISTICS.

[From June 1, 1892, to May 31, 1893.]

| | |
|---|---|
| Number of steamers | 4 |
| Number of trips | 120 |
| Tonnage | 13,375 |
| Number of schooners | 24 |
| Number of trips | 60 |
| Tonnage | 3,600 |
| Total number of schooners | 28 |
| Total number of trips | 180 |
| Total tonnage | 16,975 |

Draft of steamers from 5 feet to 7½ feet. Draft of schooners from 3 feet to 6 feet.

*Comparative statement of receipts and shipments for two years.*

| Articles. | Year ending May 31, 1892. | | Year ending May 31, 1893. | |
|---|---|---|---|---|
| | Tons. | Value. | Tons. | Value. |
| *Shipments.* | | | | |
| Lumber, shingles, and laths | 5,958 | $48,951 | 10,567 | $86,127 |
| Wood | 5,231 | 8,405 | 4,406 | 5,910 |
| Staves | 388 | 1,764 | 261 | 1,229 |
| Sugar and molasses | ........ | ........ | 61 | 5,187 |
| Cotton and cotton seed | 1,619 | 174,090 | 872 | 67,910 |
| Miscellaneous | 40 | 5,405 | 41 | 3,164 |
| Total | 13,236 | 238,615 | 16,208 | 169,527 |
| *Receipts.* | | | | |
| Estimated at | 5,294 | 95,446 | 5,891 | 176,730 |
| Total | 18,530 | 334,061 | 22,099 | 346,257 |
| Increase over previous year | ........ | ........ | 3,569 | 12,196 |

*Comparative statement of receipts and shipments for four years.*

| Year ending May 31— | Tons. | V |
|---|---|---|
| 1890 | 84,295 | $ |
| 1891 | 17,792 | |
| 1892 | 18,530 | |
| 1893 | 22,099 | |

## S 4.

## IMPROVEMENT OF BAYOU LAFOURCHE, LOUISIANA.

In 1879 a project was approved for removing the obstruction navigation in the bayou, such as snags, wrecks, raft heaps, and pending trees. Work was carried on under this project from until 1883, when the plant was laid up at Lockport after clearing bayou a distance of 30 miles below that point.

In 1884 a project was approved for continuing the snagging op tions on down beyond the place where work had ceased in 1883, accordingly work was resumed in September, 1884, and continued January, 1885, when operations were suspended on account of l water. The plant was subsequently removed to other places.

Beyond surveys and examinations nothing further was done u 1888, when Congress appropriated for "improving Bayou Lafour Louisiana, pursuant to the project of Lieut. O. T. Crosby, Corp Engineers, dated June 11, 1886, $50,000, including immediate dredg to secure low-water navigation."

During eight months of the year, when the Mississippi river is hi Bayou Lafourche is navigable by the largest steamboats, but dur extreme low water navigation is sometimes entirely suspended for boats drawing over 2 feet of water.

The project referred to in the foregoing act was to place a lock in Mississippi end of the bayou, converting the bayou into a slack-wa stream, and then dredge a channel 75 feet wide and 5 feet deep mean low water of the gulf throughout its length.

The act also provided for immediate dredging, and since the bar the river end of the bayou had shut out navigation in 1887, it was p posed to dredge a channel through this bar, the channel to have a de of 4 feet below mean low water of the gulf, and a width of 60 feet. T dredging was done by contract and admitted sufficient water to t bayou to re-ëstablish flatboat navigation, which had been suspend a day or two while the cut was being made.

It having been ascertained that about 150,000 cubic yards of mater would have to be dredged from the bayou to secure 2 feet depth f flatboat navigation, bids were opened June 10, 1889, for dredging th amount, but the price bid was deemed too high and the bid was rejecte Work was then begun by a hired dredge and continued until hi water interfered.

The channel had been carried a distance of about 2 miles from t mouth, and had a depth of 2 to 3 feet at mean low water of the gu Upon commencing this dredging it was found that the channel throu the bar at the head of the bayou had shoaled so as to require redred ing, and much of the channel work had to be gone over several time owing to the caving of the sides of the cut. On September 15, 189 dredging was resumed. The dredge had, as formerly, to reopen th cut through the bar at the head of the bayou, and redredge much of the channel previously gone over. The work was suspended in January, 1891, owing to high water, was resumed again on August 5, 1891, and continued until high water again caused its suspension in the latter part of January, 1892.

Upon the subsidence of the high water, work was resumed on August 27, 1892. In order to prosecute the work more vigorously during the low-water season to preserve the flatboat navigation, authority was obtained to hire an additional dredge.

The work was commenced at Donaldsonville and was carried on down to the mouth of the bayou, improving about 100 miles of channel, and making flatboat navigation available for the entire low-water season, by the removal of 117,906 cubic yards of material, 315 stumps, 255 logs, 76 snags, and 29 wrecks. Operations were discontinued April 14, 1893, owing to high water.

As the silting up of the dredged channel takes place with the recurrence of high water each year, the improvement by dredging is slow and unsatisfactory. The construction of a lock at Donaldsonville will almost entirely overcome this difficulty and render the navigation of the bayou safe and certain under all conditions of the tide in the Mississippi River.

The cost of a lock at Donaldsonville was estimated by Lieut. Crosby to be about $450,000. With this lock completed, whatever dredging was done in the bayou thereafter would be practically permanent, and a moderate annual expenditure would maintain satisfactory navigation hardly possible to secure with any amount of money under the present conditions.

There has been expended on the improvement of this bayou to June 30, 1893, the sum of $105,334.53.

*Abstract of appropriations for improving Bayou Lafourche, Louisiana.*

| | |
|---|---|
| By act of Congress approved— | |
| June 18, 1878 | $10,000 |
| March 3, 1879 | 10,000 |
| June 14, 1880 | 5,000 |
| July 5, 1884 | 5,000 |
| By act of Congress of August 11, 1888 | 50,000 |
| By act of Congress approved— | |
| September 19, 1890 | 50,000 |
| July 13, 1892 | 50,000 |
| Total | 180,000 |

*Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $56,656.20 |
| Amount appropriated by act approved July 13, 1892 | 50,000.00 |
| | 106,656.20 |
| June 30, 1893, amount expended during fiscal year | 31,990.73 |
| July 1, 1893, balance unexpended | 74,665.47 |
| Amount (estimated) required for completion of existing project | 350,000.00 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895 | 100,000.00 |
| Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893. | |

## COMMERCIAL STATISTICS.

[From June 1, 1892, to May 31, 1893.]

Number of steamers..........................................
Number of trips out of bayou ...............................
Aggregate tonnage of same ..................................
Number of barges entering bayou ............................
Aggregate tonnage of same ..................................
Total vessels ..............................................
Total trips ................................................
Total tonnage ..............................................

In addition to the above, there are three steamers running between points
bayou carrying passengers, which, during the year, made 230 trips, the t
aggregating 10,075 tons. Besides, there are 9 barges which ply regularly f
lower end of the bayou, carrying freight of all kinds in connection with a r
There are 50 other barges which carry all kinds of freight (when the water
in the bayou), connecting with the steamers on the river at the head of the
The carrying capacity of these 59 barges is equal to 5,151 tons.

*Receipts and shipments for two years.*

| Articles. | Year ending May 31, 1892. | | Year ending 1893. | |
|---|---|---|---|---|
| | Tons. | Value. | Tons. | V |
| *Shipments.* | | | | |
| Sugar | 26, 330 | $2, 531, 155 | 40, 764 | $4, |
| Molasses | 17, 334 | 510, 250 | 19, 953 | |
| Rice | 3, 337 | 162, 978 | 6, 549 | |
| Potatoes and onions | 2, 738 | 73, 032 | 10, 286 | |
| Eggs | 159 | 16, 308 | 92 | |
| Moss | 196 | 9, 825 | 208 | |
| Pecans | 4 | 2, 100 | 68 | |
| Miscellaneous | 275 | 7, 441 | 394 | |
| Total | 50, 373 | 3, 313, 089 | 78, 314 | 5, |
| *Receipts.* | | | | |
| Miscellaneous | 32, 562 | 1, 991, 853 | 67, 634 | 2, 4 |
| Coal | 88, 920 | 355, 680 | 66, 528 | 2 |
| Grand total | 171, 855 | 5, 660, 622 | 212, 476 | 8, 4 |
| Increase over last year | ........ | ........ | 40, 621 | 2, 7 |

*Comparative statement of receipts and shipments for four years.*

| Year ending May 31— | Tons. | Val |
|---|---|---|
| 1890 | 200, 746 | $5, 70 |
| 1891 | 217, 273 | 8, 24 |
| 1892 | 171, 855 | 5, 66 |
| 1893 | 212, 476 | 7, 42 |

During a portion of the low-water season, and on account of the bars or lu
the steamers are unable to enter the bayou, all business with them being transa
by means of barges. Not infrequently the water has been so shallow over these
that even the barges could not run, and navigation entirely suspended, much of
freight having to be hauled by wagons instead; this, too, during the harvest ti
when transportation is the most needed. But this year, owing to the dredging d
there was no such interruptions. When the steamboats could not enter there
barge water, and a considerable increase in tonnage and shipments has resulted.

## S 5.

### IMPROVEMENT OF BAYOU TERREBONNE, LOUISIANA.

Previous to the commencement of the improvement of the Bayou Terrebonne, it was a little better than a drainage ditch in places.

The project adopted for the improvement of this bayou contemplated the dredging of a channel 4 feet at mean low water of the Gulf to Houma, and, with the appropriation of $10,000, made in 1880, the work of dredging was commenced in that year and continued until December 17, 1887, when the channel was completed to the railroad depot at Houma, where a turning basin was dug.

The improvement enables planters on the bayou to float their produce to Houma, the nearest railroad station, or else ship by boat direct to New Orleans by way of connecting bayous and canals.

It is doubtful if the improvement can be made permanent, as more or less silt finds its way into the bayou, causing shoals to form which will require removal from time to time.

No work has been done during the past year, and it is not believed that more work will be required during the ensuing year than can be secured with the funds remaining available.

The estimated cost of the improvement was $38,800. The completion of the project has cost $35,808, leaving $2,992 still unexpended.

*Abstract of appropriations for improving Bayou Terrebonne, Louisiana.*

| | |
|---|---|
| By act of Congress approved— | |
| June 14, 1880 | $10,000 |
| March 3, 1881 | 8,000 |
| By act of Congress— | |
| Passed August 2, 1882 | 7,000 |
| Approved August 5, 1886 | 10,000 |
| Of August 11, 1888 | 3,000 |
| Total | 38,800 |

*Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $2,992.00 |
| July 1, 1893, balance unexpended | 2,992.00 |

COMMERCIAL STATISTICS.

[From June 1, 1892, to May 31, 1893.]

| | |
|---|---|
| Number of steamers | 3 |
| Number of trips | 15 |
| Tonnage | 3,300 |
| Number of barges | 3 |
| Number of trips | 9 |
| Tonnage | 2,225 |
| Total vessels | 6 |
| Total trips | 24 |
| Total tonnage | 5,525 |

During the fiscal years 1891 and 1892 there were no steamboats running to New Orleans direct, owing to the difficulties and expense of navigation, but this year the merchants and planters secured at their own cost means of transportation with the above result. They are also building with their own means a dredge to deepen the bayou at its lower end.

*Receipts and shipments.*

| Articles. | Tons. |
|---|---|
| Sugar and molasses | 1,189 |
| Miscellaneous freight | 121 |
| Coal | 1,700 |
| Total | 3,010 |

## S 6.

## IMPROVEMENT OF BAYOU PLAQUEMINE, GRAND RIVER, AND PI BAYOUS, LOUISIANA.

Prior to 1867 or 1868 Bayou Plaquemine was navigable by the la steamboats, but some time during the years mentioned the police of Iberville Parish, without warrant of law, caused a dike to be across the bayou, shutting out the water of the Mississippi River.

Steamers which had used the Plaquemine route to the Teche Courtableau were thus forced to go by way of the mouth of the River and the Atchafalaya, and at low water, owing to the closi the mouth of Red River, are compelled to cease running.

The opening of this bayou is therefore of great importance, a opened, it would furnish communication at all seasons with the gable waters of northern and western Louisiana, which are state good authority to have an available length of 4,300 miles.

In 1885 a project for the improvement of this bayou, by buildi lock to connect it with the Mississippi River, and clearing out the c nel so as to give a depth of 6 feet at mean low-water level of the was presented. This improvement was estimated to cost $1,708,25

In 1888 $100,000 was appropriated "for securing a navigable c nel 60 feet wide and 6 feet in depth from deep water up to Plaquemine Dike, and for securing the mouth of the bayou from fur caving."

As there was no plant at the disposal of this office for the const tion of dikes, etc., $75,000 of this appropriation was allotted for const tion of bank protections and turned over to the officer in charge of fourth district of the Misssissippi River in May, 1889.

With the remainder of the funds, dredging was commenced Jun 1889, at a point about 5 miles below the town of Plaquemine, the w being done with a dredge belonging to the United States and hi labor.

Owing to the railroad bridge not being a drawbridge, it was not p sible to continue the dredging up to the Plaquemine Dike, as specif in the act of appropriation. The project was accordingly modified as to stop dredging when the railroad bridge was reached, and wh that was accomplished the dredge was turned back and worked do to a point one-half mile below, when work was discontinued and t plant laid up and placed in charge of a watchman.

August 20, 1892, while in charge of a watchman, the dredge boat sa at her moorings. Measures were at once taken to raise the boat, a on September 5 she was floated. An inspection showed the necessi for a general overhauling, and authority therefor having been obtaine repairs were commenced at once and finished November 20, 1892.

From this date until January 1, 1893, the boat was employed in i proving the bayou, removing all obstructions for a distance of 3½ mil

The total amount of material removed from Bayou Plaquemine since the commencement of the improvement is 219,987 cubic yards, 1,706 logs, snags, and stumps, many of the latter requiring the use of dynamite to break them up.

### GRAND RIVER AND PIGEON BAYOUS.

The last river and harbor act provided that these streams "forming a portion of the Bayou Plaquemine route" should be improved, and January 1, 1893, the dredge boat was ordered to Grand River for that purpose.

Work was continued between bayous Sorrel and Pigeon until March 22, 1893, when the rapid rise of the river forced its discontinuance in Upper Grand River, and the dredge was consequently ordered to Flat Lake on the lower end of this river, with a view of opening up the route to the Teche and Atchafalaya, via Grand River.

The operations in Grand River resulted in the removal of 13,826 cubic yards of material, 5,525 overhanging trees, 667 logs, 16 snags, and 55 stumps.

### PIGEON BAYOUS.

An examination of Big and Little Pigeon bayous has been made, and arrangements are now being made which will cause the removal of all obstructions in these streams.

When completed a connection will be opened by which steamboats from the Teche can make connection on Lower Bayou Plaquemine with the Texas and Pacific Railway, and thus open a new competing route.

### PLAQUEMINE LOCK.

In 1890 $100,000 was appropriated for continuing the improvement of Bayou Plaquemine, of which sum $60,000 was allotted for completing the bank protection on the Mississippi River, and $40,000 was allotted to this office.

Under this last allotment a project for the commencement of work upon a lock to connect the Mississippi River with the bayou was presented, and a board of engineer officers was appointed to consider the subject.

Under the direction of this board plans for a lock of sufficient size to pass four coal boats, or the largest steamers which would be liable to make use of that one lockage, were prepared.

In 1892 $150,000 was appropriated, with a proviso that "of which sum not exceeding $10,000 may be used, in the discretion of the Secretary of War, in removing obstructions from Grand River and Pigeon Bayous, forming part of the Bayou Plaquemine route."

As the amount available for the construction of the lock was not sufficient to warrant the commencement of the work, it has been held subject to an increase. The estimated cost of lock and approaches is $700,000.

During the present year measures were taken to secure the land necessary for the sites and approaches to the lock, and it was found necessary to institute proceedings to expropriate the lands and riparian rights involved. All the suits have been tried, but as some legal technicalities still remain to be adjusted the titles have not as yet vested in the United States.

Since the bayou is not navigated by vessels engaged in the transportation of merchandise, owing to the communication with the Mississippi

River being cut off, the commercial statistics give no indicatio importance of this water route when communication with the sippi River shall have been established.

Some idea of the importance of this line of communicatio gleaned from the following table of the value of the commerce upon the various streams to which access will be afforded by t pletion of the Plaquemine Lock. The figures are compiled fi report of the Chief of Engineers, and are for the year ending 1891.

| | |
|---|---|
| Red River | $6 |
| Ouachita and tributaries | 6 |
| Courtableau and Des Glaises | 3 |
| Bayou Plaquemine | |
| Bayou Teche | 1 |
| Bayou Vermillion | 1 |
| Total | 20 |

During the year a draw span has been placed in the railroad at Plaquemine.

It is not deemed prudent to commence the foundations of tl with less funds available than may be required for the bringing foundation up to the level of low water in the bayou. It is the respectfully urged that sufficient funds be furnished to accompli without delay.

The amount expended on this improvement to June 30, 1893 funds allotted to this office was $32,652.55, $1,000 of which w pended for preliminary examinations and surveys from the allo of $75,000 for bank protection at the mouth of the bayou.

For continuing the work of improving Grand River and P bayous, forming a part of the Bayou Plaquemine route, it is r mended that $10,000 be appropriated for the next year, the comp of which work will afford immediate temporary relief to the com of the Teche country.

*Abstract of appropriations for improving Bayou Plaquemine, Louisiana.*

| | |
|---|---|
| By act of Congress— | |
| Of August 11, 1888 | $1 |
| Approved September 19, 1890 | 1 |
| Approved July 13, 1892 | 1 |
| Total | 3 |

*Money statement.**

| | |
|---|---|
| July 1, 1892, balance unexpended | $73, 2 |
| Amount appropriated by act approved July 13, 1892 | 150, 0 |
| | 223, 2 |
| June 30, 1893, amount expended during fiscal year | 12, 8 |
| July 1, 1893, balance unexpended | 210, 4 |
| July 1, 1893, outstanding liabilities | 32, 9 |
| July 1, 1893, balance available | 177, 5 |
| Amount (estimated) required for completion of existing project | 1, 358, 2 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895 | 500, 0 |
| Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893. | |

---

* This money statement includes amounts for securing mouth of Bayou Plaque from further caving. (See Appendix T.)

### COMMERCIAL STATISTICS.

[From June 1, 1892, to May 31, 1893.]

| | |
|---|---|
| Number of steamers | 8 |
| Tonnage | 490 |
| Number of trips made | 241 |
| Tonnage | 8,607 |

Much satisfaction is expressed over the dredging already done. Hitherto the navigation of the Bayou Plaquemine had been uncertain and unsatisfactory; now it is assured and profitable. Steamers are now running regularly from Plaquemine to Grand River and Bayou Sorrel for the first time in years. The lumber men in particular are benefitted, and two new sawmills have been built, making nine mills within a distance of 7 miles of Plaquemine.

*Shipments for two years.*

| Articles. | June 1, 1891, to May 31, 1892. | | June 1, 1892, to May 31, 1893. | |
|---|---|---|---|---|
| | Tons. | Value. | Tons. | Value. |
| Sugar and molasses | 2,263 | $142,920 | 1,254 | $117,730 |
| Moss | 55 | 2,750 | 25 | 1,320 |
| Miscellaneous freight | 927 | 58,268 | 350 | 21,000 |
| Cotton and cotton seed | ........ | ........ | 83 | 3,850 |
| Lumber, shingles, etc | 128,630 | 1,139,670 | 77,044 | 1,030,850 |
| Total | 131,875 | 1,343,608 | 78,756 | 1,174,750 |

## S 7.

## IMPROVEMENT OF BAYOU COURTABLEAU, LOUISIANA.

During the high water in the Atchafalaya River a bar forms at the mouth of the Courtableau, but upon the subsidence of the Atchafalaya the reflex water of the bayou causes some scour to take place on the bar.

Acting upon the supposition that if all the water carried by the Courtableau was concentrated upon the bar obstructing its mouth it would be removed a project was approved in 1879 which had for its object the closing of all bayous flowing out of the Courtableau to the southward, to prevent any escape of water by these lateral streams, and to construct locks and dams so as to make slack-water navigation, first, to Port Barre, 17 miles upstream, and then to Washington, La., 11 miles farther up.

The preliminary estimate for the cost of this work was $40,000, which was afterwards increased to $78,500, and it was reported in the Annual Report of 1886 that the cost of masonry, lock, and dam would be $175,000.

In 1882 dams were built on the Big and Little Fordoche bayous, and timber was slashed into the smaller bayous so as to concentrate the flow of water over Little Devil Bar. The result was favorable, and 3 feet increased depth of water was obtained in two days.

It was reported that the swampers cut one of these dams afterwards and Little Devil Bar again shoaled up. In 1885 the cut dam was rebuilt and the other one repaired. A sudden rise caused one of these dams to break, but it was repaired, and during the following summer good results were hoped from the effect the two dams would produce.

In the summer of 1886 the Courtableau was exceptionally low, and Little Devil Bar was shoaler than ever. At its lowest stage a skiff could not be floated over the bar.

From the report of Lieut. Crosby (Annual Report, Chief
gineers, for 1887, page 1376), who made an examination of this
in September, 1886, it will be seen that the prospects of succes
with all the runout bayous closed, are anything but certain,
closing of two of the principal outlets in one season did prod
increase of 3 feet depth of water. In view of this fact, and th
project called for the closing of these bayous, work was resur
October, 1886, with the money appropriated in August of that

Slight repairs were made to the old dams in the Big and Littl
doche and a new dam was built in Bayou English. Bayou Ma
was similarly closed, and the wings of the dam closing the Big Fo
were repaired. At the time work ceased in December the ba
cutting out rapidly, there being then a channel of from 3 to 5 feet
while when work began there was one of but a few inches in
The new channel was then of no use, however, as the closure c
River permitted no boats to enter the Atchafalaya from the Missi
River.

The high water of 1888 formed the bar again, as usual, depo
sand to a depth of probably 6 or 8 feet over a length of 2 miles.

From a personal examination made in October, 1888, by Capt.
during low water, it was observed that the preceding high wate
cut around one end of each of the dams already built, but they
caused a sand bar to form at each, varying in height from 2 to
feet above the water in the Courtableau at the time of the examin
thus forcing all the water in the bayou to pass out into the Atchaf
across Little Devil Bar, the head of which was then some 300 o
yards above the Little Fordoche. The volume of water, conside
greater than usual at low water, due to heavy local rains, was ru
with great velocity, and was moving a large quantity of sand, as
be plainly seen, but the depth at the shoalest point could not have
greater than 18 inches.

Had the bar been cut out to a suitable depth for navigation
doubtful if it would have left sufficient water in the bayou abov
purposes of navigation.

As soon as possible preparations were begun after high wat
1888 to repair the existing dams and to build others and for clo
some of the remaining outlets, but before the plant which was t
used on the work could be put in repair the water rose to such a he
that nothing could be done.

The water having fallen sufficiently, work was resumed on Sep
ber 2, 1889. The broken dams in bayous Mamzelle, English,
Fordoche were all repaired and left in good condition. Bayous
Cane and Little Cane, both of which are small and of little importa
were obstructed by slashing trees into them, and the boats take
Bayou Juramon on November 23 for work, but the water ros
rapidly the plant and lumber had to be taken to Washington, laid
and the crew discharged November 30, 1889.

Nothing was done during the fall of 1890 beyond slight repair
the derrick boat, and, owing to high water, work was not resu
until September of the following year.

The dams at Bayous Cane, Mamzelle, and Big Fordoche were
repaired with piles and sheet piles, brush aprons placed above
below them, held down by sinking trees and earth, and left in g
order. The work was discontinued November 20 and the plant
up at Washington, La.

The plant used on this work consists of a quarter boat for the crew, and a flat supplied with a pile-driver for use in building dams, and the usual supply of tools and appliances for this class of work.

Through the influence of the dams constructed the bar has washed out so as to give a navigable depth at a stage of water in the Atchafalaya 7 feet below the level at which navigation was interrupted in the summer of 1891, but it is doubtful if the completion of the present project will permanently remove the bar at the mouth, as Little Devil Bar will reform at each high water of the Atchafalaya River.

The dams are in fairly good condition, but will require extensive repairs in another year, particularly the older ones.

No work was done during the past year beyond the care of the property and plant.

To June 30, 1893, there has been expended on the improvement of Bayou Courtableau the sum of $31,042.55.

For continuing the improvement by constructing dams and repairs to those already built the sum of $5,000 can be economically expended during the ensuing year.

The plant formerly used on this improvement having deteriorated and being of no further service for this work, it was sold at public auction June 20, 1893.

*Abstract of appropriations for improving Bayou Courtableau, Louisiana.*

| | |
|---|---|
| By act of Congress approved— | |
| June 14, 1880 | $7,500 |
| March 3, 1881 | 7,500 |
| July 5, 1884 | 4,000 |
| August 5, 1886 | 5,000 |
| By act of Congress— | |
| Of August 11, 1888 | 5,000 |
| Approved September 19, 1890 | 2,200 |
| Total | 31,200 |

*Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $418.30 |
| June 30, 1893, amount expended during fiscal year | 260.85 |
| July 1, 1893, balance unexpended | 157.45 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895<br>Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893. | 5,000.00 |

COMMERCIAL STATISTICS.

[From June 1, 1892, to May 31, 1893.]

| | |
|---|---|
| Number of steamers | 5 |
| Number of trips | 96 |
| Tonnage | 20,068 |

*Receipts and shipments for two years.*

| Articles. | Year ending May 31, 1892. | | Year ending 1893. | |
|---|---|---|---|---|
| | Tons. | Value. | Tons. | V |
| *Shipments.* | | | | |
| Sugar and molasses | 972 | $67, 157 | 467 | |
| Rice | 600 | 22, 500 | 2, 075 | |
| Cotton and cotton seed | 11, 717 | 564, 149 | 4, 497 | |
| Miscellaneous | 72 | 9, 175 | 107 | |
| Total | 13, 361 | 662, 981 | 7, 146 | |
| *Receipts.* | | | | |
| Estimated at | 6, 680 | 331, 490 | 7, 702 | |
| Total | 20, 041 | 994, 471 | 14, 848 | |

*Comparative statement of receipts and shipments for four years.*

| Year ending May 31— | Tons. | Va |
|---|---|---|
| 1890 | 35, 867 | $4, 6 |
| 1891 | 32, 618 | 3, 9 |
| 1892 | 20, 041 | 9 |
| 1893 | 14, 848 | 6 |

## S 8.

## IMPROVEMENT OF BAYOU TECHE, LOUISIANA.

Ordinarily this bayou is navigable for steamboats throughout year.

Prior to 1886 logs, snags, and impending trees obstructed the ch nel, but money having been appropriated the stream was thoroug cleared of such obstructions from Port Barre down.

In 1890 Congress appropriated $5,000 with which to remove the structions that had found their way into the bayou since 1886.

Operations were commenced at St. Martinsville in October, 18 with hired plant, and the improvement extended to a point about miles below. Work was discontinued December 10, 1891. The m obstructions removed from the channel as the result of the yea work were 238 snags, 144 piles, 98 overhanging limbs, 36 overhangi trees, 30 fallen trees, 50 sunken logs, 18 floating logs, and 37 stum

To the close of the year ending June 30, 1893, there has been pended on the improvement of this stream the sum of $54,387.49.

The improvement of the Teche can not be considered as permane as sunken logs, fallen trees, and wrecks of coal boats are constan forming obstructions which will require removal.

The navigation of the stream is at present also obstructed by shoa on which, during the prevalence of northers in the low-water seaso the available depth is frequently not more than 3 feet. These sho are formed by material washed into the stream from the large draina ditches, and, while no one of them is very long, they form a series dams over which it is impossible for the steamers to carry full loads. T evil is increasing, as every year new ditches are opened and old on cleaned out.

It is generally upon these shoals that the sinking logs drop out from passing rafts, making the passageway dangerous.

As the lowwater season occurs at the time of marketing the crops, this condition is becoming of serious import to the various interests involved.

It is believed that $30,000 can be most advantageously expended during the ensuing year in dredging and removing obstructions from the channel.

*Abstract of appropriations for improving Bayou Teche, Louisiana.*

| | |
|---|---|
| By act of Congress approved— | |
| July 11, 1870 | $17,500 |
| June 14, 1880 | 6,000 |
| March 3, 1881 | 20,000 |
| July 5, 1884 | 6,500 |
| September 19, 1890 | 5,000 |
| Total | 55,000 |

*Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $650.84 |
| June 30, 1893, amount expended during fiscal year | 38.33 |
| July 1, 1893, balance unexpended | 612.51 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893. | 30,000.00 |

COMMERCIAL STATISTICS.

[From June 1, 1892, to May 31, 1893.]

| | |
|---|---|
| Number of steamers | 2 |
| Number of trips | 42 |
| Tonnage | 8,500 |
| Number of barges | 75 |
| Number of trips | 75 |
| Tonnage | 62,347 |
| Total number of vessels | 77 |
| Total trips | 117 |
| Total tonnage | 70,847 |

The above refers entirely to the tonnage to and from the Mississippi River, and does not include the number of trips, or tonnage, of the three steamers and barges running from Morgan City to points on the Bayou Teche in connection with the railroad, nor does it include the steamers, their trips and tonnage, which annually tow many rafts of logs from the Atchafalaya River to the sawmills on the bayou.

*Receipts and shipments for two years.*

| Articles. | Year ending May 31, 1892. | | Year ending 1893 | |
|---|---|---|---|---|
| | Tons. | Value. | Tons. | |
| *Shipments.* | | | | |
| Sugar | 2,397 | $230,334 | 11,259 | $ |
| Molasses | 1,406 | 41,181 | 7,829 | |
| Rice | 184 | 7,143 | 4,325 | |
| Potatoes and onions | 20 | 396 | 62 | |
| Eggs | 3 | 976 | 55 | |
| Moss | 39 | 1,950 | 97 | |
| Pecans | 1 | 195 | 82 | |
| Hides | 9 | 864 | 39 | |
| Cotton and seed | 515 | 54,951 | 324 | |
| Cotton-seed oil | 204 | 12,474 | 176 | |
| Wood | 2,359 | 6,066 | ........ | |
| Miscellaneous | 48 | 4,795 | 897 | |
| Total | 7,185 | 361,825 | 25,145 | 4, |
| *Receipts.* | | | | |
| Machinery, coal, etc | 57,681 | 471,785 | 90,135 | 1 |
| Grand total | 64,866 | 833,110 | 115,280 | 5 |
| Increase over previous year | ........ | ........ | 50,414 | 4, |

*Comparative statement for three years.*

| Year ending May 31— | Tons. | V |
|---|---|---|
| 1891 | 26,905 | $1, |
| 1892 | 64,866 | |
| 1893 | 115,080 | 5, |

The statement for 1892 was for the shipments and receipts by the all-water only from the Bayou Teche via the Atchafalaya and the Mississippi rivers. I statement for 1893 is included the shipments and receipts via steamers and rai from Morgan City to New Orleans—about three-fourths of the whole.

## S 9.

## IMPROVEMENT OF CHANNEL, BAY, AND PASSES OF BAYOU VERMILI LOUISIANA.

In 1891 a preliminary examination was made of the bayou, bay, passes.

A project was approved in 1892 which provided for the remov snags, overhanging trees, and logs in the bayou, and the drivin guide piles in the bay for marking the channels, at an estimated of $25,000.

An appropriation of $7,500 was made for this work July 13, 1892

Bids were invited by advertisement for furnishing a suit equipped steamboat for the work in the bayou and bay. The propo submitted were opened October 7, 1892, and the award of contract made to Victor Von Schoeler, of Franklin, La., for the best and suitable boat of those offered.

The plant contracted for consisted of a stern-wheel steamboat, a crew of fourteen men, supplied with a steam capstan, steam wi derrick, blocks and tackle, and one electric battery for removing obstructions, and one pile-driver for driving guide piles in Vermillion Bay.

The contractor commenced snagging operations about 18 miles above the mouth of the bayou on December 1, 1892. The work was carried on up the bayou and resulted in the improvement of 37½ miles of channel by the removal of 3,032 obstructions, consisting of 2,377 overhanging trees, 416 overhanging limbs, 110 snags, 58 sunken trees, 36 stumps, and 35 logs. The contractor completed the snagging work on March 9, 1893, but owing to the loss of his boat he was unable to complete the driving of the guide piles in the bay by the date of the expiration of the contract, and an extension of time, to July 31, 1893, was granted within which to finish this work.

The sum of $10,000 can be most advantageously expended on this improvement during the next year.

The total amount expended to June 30, 1893, was $5,923.20.

*Abstract of appropriations for improving the channel, bay, and passes of Bayou Vermilion, Louisiana.*

| | |
|---|---|
| By act of Congress approved July 13, 1892 | $7,500 |

*Money statement.*

| | | |
|---|---|---|
| Amount appropriated by act approved July 13, 1892 | | $7,500.00 |
| June 30, 1893, amount expended during fiscal year | | 5,923.20 |
| July 1, 1893, balance unexpended | | 1,576.80 |
| July 1, 1893, outstanding liabilities | $623.12 | |
| July 1, 1893, amount covered by uncompleted contracts | 518.74 | |
| | | 1,141.86 |
| July 1, 1893, balance available | | 434.94 |
| Amount (estimated) required for completion of existing project | | 17,500.00 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895 | | 10,000.00 |
| Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893. | | |

*Abstract of proposals received for furnishing a snag boat, etc., for improving the channel, bay, and passes of Bayou Vermilion, Louisiana, opened at New Orleans, La., October 7, 1892, by Maj. James B. Quinn, Corps of Engineers.*

| No. | Name and address of bidder. | Prices bid per day for hire of snag boat. | Prices bid for furnishing and driving each guide pile in place. |
|---|---|---|---|
| 1 | McReynolds & Plummer, Sabine Pass, Tex | $57.50 | $6.00 |
| 2 | John Hanson, Berwick, La | 85.00 | 20.00 |
| 3 | Victor Von Schoeler, Franklin, La | 74.85 | 9.25 |
| 4 | G. D. Shaw, Abbeville, La | 47.50 | 5.50 |
| 5 | Charles Springer, New Orleans, La | 69.75 | 9.75 |
| 6 | Harvey & Erlinger, Harvey's Canal, Louisiana | 84.50 | 8.50 |

Contract awarded to Victor Von Schoeler, of Franklin, La., with the approval of the Chief of Engineers, he being the lowest bidder for the best and most suitable plant. Contract dated November 5, 1892, and approved November 11, 1892. Work to be commenced within sixty days after approval of contract, and completed on or before May 1, 1893.

### COMMERCIAL STATISTICS.

[From June 1, 1892, to May 31, 1893.]

| | |
|---|---|
| Number of steamers | |
| Number of trips made | |
| Gross tonnage | |
| Number of schooners | |
| Number of trips made | |
| Gross tonnage | |
| Number of barges | |
| Number of trips made | |
| Gross tonnage | |
| Total number of vessels | |
| Total number of trips | |
| Total tonnage | |

Average draft of steamers and barges, loaded, about 5 feet.

So far as can be learned no new lines of transportation were established d the year.

*Receipts and shipments.*

| Articles. | Tons. | V |
|---|---|---|
| Lumber | 1,200 | $ |
| Rice | 4,200 | |
| Cotton | 925 | 1 |
| Cotton seed | 1,100 | |
| Wood | 10,000 | |
| Cattle | 75 | |
| Sugar | 2,979 | 2 |
| Molasses | 957 | |
| Merchandise | 12,570 | 6 |
| Coal | 1,665 | |
| Total | 35,671 | 1,2 |

## S 10.

### IMPROVING MERMENTAU RIVER AND TRIBUTARIES, LOUISIANA.

In 1891 a survey of this river was made, including its tributaries course through Lake Arthur and Grand Lake to the Gulf of Me Louisiana.

The project adopted in 1892 was estimated to cost $23,615.25, provided for the removal of snags, logs, and overhanging trees in upper river and a mud flat in the lower.

July 13, 1892, Congress appropriated $7,500 for this improvemen

Bids were invited by advertisement for furnishing a suitable ste boat for snagging purposes. The bids submitted were opened Oct 6, 1892, and the award of contract was made to Harvey & Erlinge Harveys Canal, Louisiana, they having the best and most suit boat of those offered.

The plant contracted for consisted of a sternwheel steamboat, w a crew of 15 men, supplied with a steam capstan, steam winch, two derricks for removing obstructions, one electric battery for blast stumps, and all other necessary appliances for this class of work.

Work under this contract was commenced December 8, 1892, at lower end of Lake Arthur, and proceeded on up the Mermentau Ri improving that part of the channel most used for a distance of 38 m by removing 556 obstructions, consisting of 383 snags, 172 overhang trees, and 1 wreck. The contract was completed March 7, 1893.

The sum of $10,000 can be advantageously expended on this impro ment during the next year.

The total amount expended on these streams to June 30, 1893, was $7,054.03.

*Abstract of appropriations for improving Mermentau River and tributaries, Louisiana.*

| | |
|---|---|
| By act of Congress approved July 13, 1892 | $7,500 |

## *Money statement.*

| | |
|---|---|
| Amount appropriated by act approved July 13, 1892 | $7,500.00 |
| June 30, 1893, amount expended during fiscal year | 7,054.03 |
| July 1, 1893, balance unexpended | 445.97 |
| Amount (estimated) required for completion of existing project | 16,115.25 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895 | 10,000.00 |
| Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893. | |

*Abstract of proposals received for furnishing a steamboat for improving Mermentau River and tributaries, Louisiana, opened at New Orleans, La., October 6, 1892, by Maj. James B. Quinn, Corps of Engineers.*

| No. | Name and address of bidder. | Prices bid per day for hire of steamboat. |
|---|---|---|
| 1 | McReynolds & Plummer, Sabine Pass, Tex | $55.00 |
| 2 | Harvey & Erlinger, Harveys Canal, Louisana | 98.00 |
| 3 | G. B. Shaw, Abbeville, La | 89.00 |
| 4 | Charles Springer, New Orleans, La | 73.75 |

Contract awarded to Harvey & Erlinger, of Harveys Canal, Louisiana, with the approval of the Chief of Engineers, at $98 per day, they being the lowest bidders for the best and most suitable boat. Contract dated November 4, 1892, and approved November 11, 1892. Work to be commenced within ninety days after approval of contract, and completed on or before May 1, 1893.

### COMMERCIAL STATISTICS.

[From June 1, 1892, to May 31, 1893.]

| | |
|---|---|
| Number of steamers | 6 |
| Number of trips made | 90 |
| Total tonnage | 23,760 |
| Number of barges | 8 |
| Number of trips made | 90 |
| Total tonnage | 3,600 |
| Total number of trips | 180 |
| Total tonnage | 27,360 |

Average draft of steamers and barges, loaded, about 4 feet.

So far as learned no new lines of transportation were established during the year.

## *Receipts and shipments.*

| Articles. | Tons. | Value. |
|---|---|---|
| Rice | 11,900 | $309,400 |
| Lumber | 150 | 1,500 |
| Wood | 4,000 | 4,000 |
| Merchandise | 200 | 10,000 |
| Total | 16,250 | 324,900 |

## S 11.

## IMPROVEMENT OF MOUTH AND PASSES OF CALCASIEU RIVER, LOUISIA

In 1874, and again in 1882–'83, cuts were made through the bars Calcasieu Lake, above Calcasieu Pass. The dredged channel wa feet deep, 70 feet wide, and 7,500 feet long. The work was done un contract.

The channel had again shoaled in 1885 to a depth of 3½ feet a needed redredging, but, by an unfortunate wording of the appropr tion, funds in hand for "improving Calcasieu River" could not be plied to this particular work. In 1886 this was remedied, and fun heretofore appropriated for Calcasieu River became available for bo the pass and river.

Contracts were made in 1886 for building two revetment walls piles and planks, one on each side of the proposed cut, to be abo 130 feet apart, each to be a mile or more in length, and between the to dredge a channel 100 feet wide and 6 feet deep, the material ex vated to be thrown outside the revetment walls.

The same contract also provided for the excavation of a chan through the bar at the mouth of Calcasieu River, at the northern e of the lake, 100 feet wide and 6 feet deep. Work was commenced the revetments in the winter of 1886, but the weather was so seve that the contractor and several of his men died from sickness due exposure on this work.

In the spring of 1887 work was resumed by the administrator of t contractor's estate, and the revetment nearly completed. At the da of the Annual Report for 1887 a dredge was expected to begin wo within a few weeks, and actually arrived there about the middle August, but was not ready for work until the last of November on a count of the repairs necessary and the delay in making them.

About the middle of September, when it was thought the dred would be ready for work in a few days at the very latest, the admini trator began driving down the planking of the revetment into t ditch the water had dug under it, but after one day's work stoppe No work was done by him after that time, and the contract was a nulled January 3, 1888.

Authority was obtained from the Chief of Engineers to do this wor by hired labor and open-market purchase, using the Government dredg which had shortly before finished the improvement of Bayou Terr bonne. A careful examination developed the fact that the reve ment was so badly worm eaten as to be worthless, showing that t life of timber there was short. Application was made to so far modi the project as to omit the revetment, and this modification was a proved by the Chief of Engineers January 12, 1888. The dredge wa put in good condition and began work on the 19th of March.

Two deck barges were hired and arranged for use as dump scow but two days' work with them showed that the wooden shafts or Spa ish windlasses, used for closing the dumping doors, were not stron enough. These were replaced with 3-inch iron shafting and worke well. The material taken out by the dredge amounted to 77,159 cubi yards, completing the work as projected August 31, 1888.

In 1888 $10,000 was appropriated for continuing this work, but a the former work did not prove to be permanent, and the amount wa too small to begin operations with, it was held subject to future consid eration.

In 1890 Congress appropriated $75,000 for "improving the mout and passes of Calcasieu River" according to the plan reported by Maj. W. H. Heuer, Corps of Engineers, in 1886, and confirmed by Capt. W. L. Fisk, Corps of Engineers, in his report of November, 1888.

As this project was for the improvement of the mouth of the Calcasieu River by means of jetties, etc., which must be built in a very much exposed location in the Gulf, the amount of money available was considered to be entirely too small with which to commence operations, economically, and was accordingly held for future increase.

The act approved July 13, 1892, appropriated $100,000 for the improvement of the passes and river, and accordingly a contract was let for the construction of a jetty upon the east side of the channel across the bar at the mouth of the pass, and a contract for 10,000 linear feet of revetment for the northern side of a channel to be dredged through the bar at the head of the pass. For the dredging, although advertised, no bid was received sufficiently low to warrant acceptance, and accordingly it will be done by the Government dredge.

The revetment has been nearly completed, and will probably be wholly so by the end of July.

The east jetty has been built out a distance of but 1,104 feet from the shore, owing to very unfavorable weather retarding the work. This jetty will be similar to those at Sabine Pass, viz, a foundation mat of brush, and upon this a riprap structure to reach 2 feet above mean high water.

The material placed in the east jetty during the year consisted of 1,893.56 tons of riprap stone and 2,453.33 square yards of brush mattress.

The total amount expended on the improvement to June 30, 1893, was $56,462.95.

Some idea of the commerce which will be benefited by the completion of the improvement may be inferred from the statistics herewith.

*Abstract of appropriations for improving mouth and passes of Calcasieu River, Louisiana.*

| | |
|---|---|
| By act of Congress approved— | |
| June 10, 1872 | $15,000 |
| March 3, 1881 | 15,000 |
| By act of Congress— | |
| Passed August 2, 1882 | 10,000 |
| Approved July 5, 1884 | 6,500 |
| Of August 11, 1888 | 10,000 |
| Approved September 19, 1890 | 75,000 |
| Approved July 13, 1892 | 100,000 |
| Total | 231,500 |

*Money statement.*

| | | |
|---|---|---|
| July 1, 1892, balance unexpended | | $84,935.40 |
| Amount appropriated by act approved July 13, 1892 | | 100,000.00 |
| | | 184,935.40 |
| June 30, 1893, amount expended during fiscal year | | 9,898.35 |
| July 1, 1893, balance unexpended | | 175,037.05 |
| July 1, 1893, outstanding liabilities | $10,231.31 | |
| July 1, 1893, amount covered by uncompleted contracts | 135,386.67 | |
| | | 145,617.98 |
| July 1, 1893, balance available | | 29,419.07 |
| Amount (estimated) required for completion of existing project | | 425,000.00 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895 | | 350,000.00 |

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

### COMMERCIAL STATISTICS.

[From June 1, 1892, to May 31, 1893.]

| | |
|---|---|
| Number of steamers | |
| Number of trips made | 1 |
| Gross tonnage | 24 |
| Number of schooners | |
| Number of trips made | |
| Gross tonnage | 3 |
| Number of barges | |
| Number of trips made | |
| Gross tonnage | 15 |
| Total number of vessels | 1 |
| Total tonnage | 267 |

The large shipments of lumber heretofore made to Mexican and Central Ameri ports can not be made now because it is claimed that the depth of water on the will admit only the lighter class of vessels.

*Receipts and shipments.*

| Articles. | Tons. | Val |
|---|---|---|
| Lumber | 180,000 | $990 |
| Shingles | 6,000 | 60 |
| Cotton | 525 | 68 |
| Cotton seed | 550 | 6, |
| Rice | 252 | 6, |
| Merchandise | 20,218 | 1,010, |
| Total | 207,545 | 2,141, |

## S 12.

## IMPROVEMENT OF HARBOR AT SABINE PASS, TEXAS.

The original depth of water on the bar obstructing the entrance Sabine Pass, Texas, did not exceed 6 feet. Attempts were made 1878 and 1880 to increase this to 12 or 16 feet by dredging, but t dredged channels being unprotected soon filled up. In 1882 a proje was approved for improving this entrance by means of jetties a dredging at an estimated cost of $3,177,606.50.

Since the approval of this project there has been appropriate $1,448,750. A total of $1,319,848.48 had been expended to June 3 1892, of which sum $999,848.48 was expended upon the present a proved project.

At the start the jetties were built of layers of brush and rock ballas but it was found that the brush which was placed in the jetties abov the bottom course almost entirely disappeared, and at present a larg brush mattress is sunk for a foundation, and the rock jetty is built upo this until the crest is about 2 feet above mean high water.

Owing to the bottom upon which the mats rest being of a rathe yielding material, some subsidence is to be expected, and in construc tion an allowance has been made for this, but upon the whole the sub sidence has not exceeded expectations. Some loss of height also re sults from the displacement of the rock by wave action, and since it i impossible to definitely separate this from actual subsidence it has no been possible to adjust the different elements of jetty construction s as to exactly meet all the conditions of permanent structure. It i hardly possible that this condition will be fully ascertained until th full depth of channel has been secured between the jetties, and consequently the advance of the work is somewhat retarded by the main-

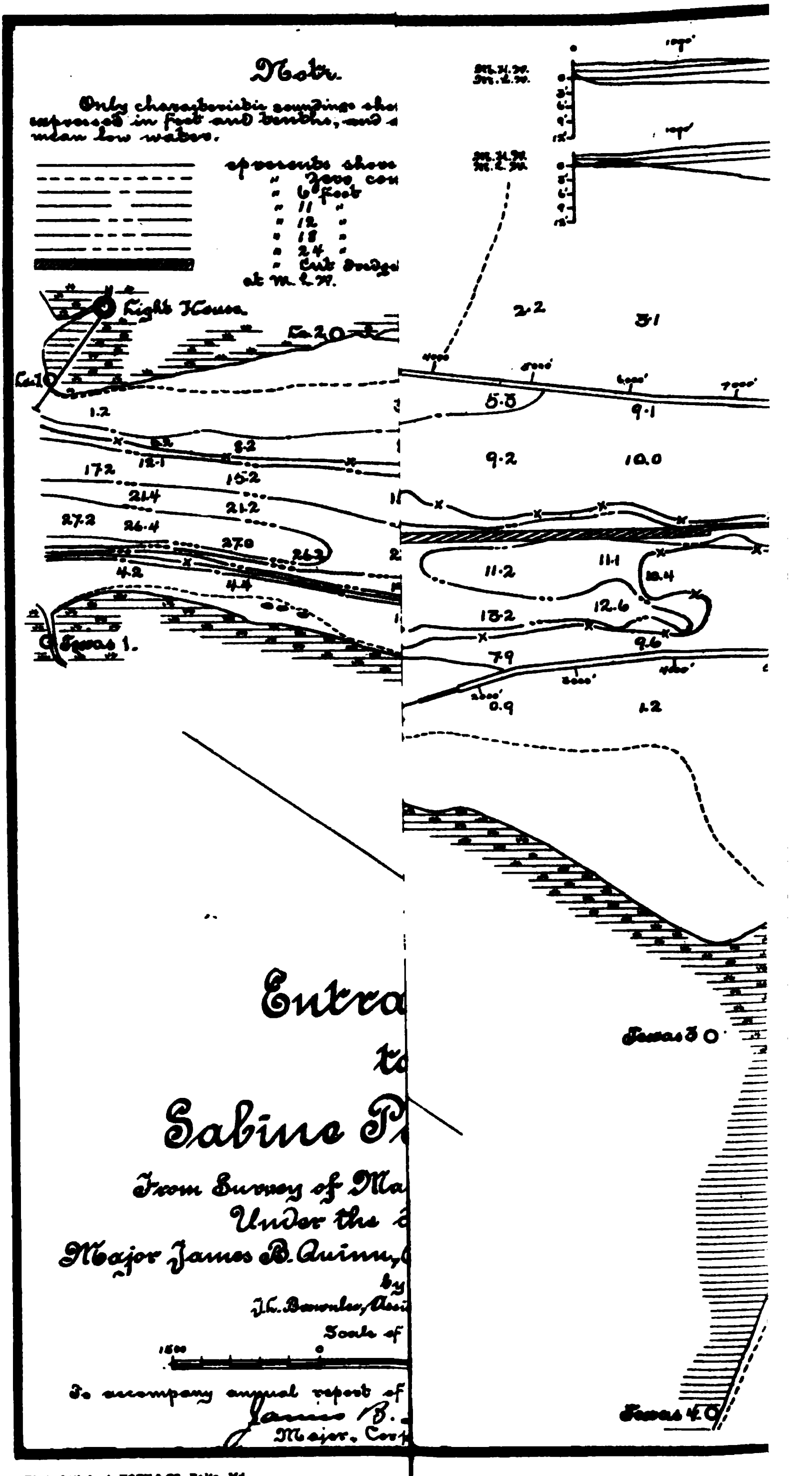

Photo-Lith by A. HOEN & CO., Balto., Md

ance of the jetties, or performance of work which correctly apper- ıs to repairs, rather than to construction.

he east jetty has a total length of 17,100 feet, 16,650 feet of which been raised to 2 feet above mean high water. The outer 450' is foundation work only.

he west jetty is 12,840 feet long. Of this 6,609 feet has been raised feet above mean high water, and 6,091 feet has only been brought he level of mean low water and is incomplete.

s the material between the jetties was not readily removed by the sive action of the water, dredging, to expedite this, was resorted to. epth of channel of 16 feet was arrived at, and it was hoped that at it a single cut through to deep water might be early secured, but gh weather has prevented the consummation of this expectation.

he dredged channel lacks about 1,500 feet of being abreast with outer end of the east jetty, and is about 5,000 feet distant from the oot curve in the Gulf.

onsiderable natural scour has taken place between the jetties and dredged channel has remained intact, showing clearly that the jet- so far afford perfect protection to the channel between them, and n the manner in which the curve of 12-foot depth has receded it is sonable to infer that some protection may also be expected to a nnel dredged beyond their extremities.

he material carried out by the natural scouring action of the cur- has not been deposited in front of the jetties, but has completely ppeared. Since the water issuing from the pass is practically de- of sediment the permanence of the channel after the works are pleted is practically assured.

he accompanying chart shows the condition of the channel, etc., e 30, 1893. It will be observed that a channel of 11 feet depth ts between the pass and the Gulf, but a vessel drawing considera- more than this can safely enter, since the bottom is very soft.

he material placed in the jetties during the year ending June 30, , consisted of 6,136.26 tons of capping stone, 31,839.84 tons of rip- and 42,139.13 square yards of brush mattress. The material lged from the channel during the year amounted to 159,376.58 cubic ls.

he total amount expended on this improvement to June 30, 1893, $1,528,593.79.

*Abstract of appropriations for improving harbor at Sabine Pass, Texas.*

| | |
|---|---|
| act approved August 30, 1852 (survey) | $5,000 |
| ed from act of Congress approved June 10, 1873 (for survey) | 2,000 |
| ct of Congress approved— | |
| arch 3, 1875 | 20,000 |
| ugust 14, 1876 | 38,000 |
| une 18, 1878 (allotted) | 30,000 |
| arch 3, 1879 | 25,000 |
| une 14, 1880 | 50,000 |
| arch 3, 1881 | 150,000 |
| t of Congress passed August 2, 1882 | 150,000 |
| t of Congress approved— | |
| uly 5, 1884 | 200,000 |
| ugust 5, 1886 | 198,750 |
| t of Congress of August 11, 1888 | 250,000 |
| t of Congress approved— | |
| eptember 19, 1890 | 300,000 |
| uly 13, 1892 | 350,000 |
| Total | 1,768,750 |

## *Money statement.*

| | | |
|---|---|---|
| July 1, 1892, balance unexpended | | $98,901.52 |
| Amount appropriated by act approved July 13, 1892 | | 350,000.00 |
| | | 448,901.52 |
| June 30, 1893, amount expended during fiscal year | | 208,745.31 |
| July 1, 1893, balance unexpended | | 240,156,21 |
| July 1, 1893, outstanding liabilities | $42,411.54 | |
| July 1, 1893, amount covered by uncompleted contracts | 171,975.48 | |
| | | 214,387.02 |
| July 1, 1893, balance available | | 25,769.19 |
| Amount (estimated) required for completion of existing project | | 1,728,856.50 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895 | | 1,000,000.00 |

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

*Abstract of proposals received for extension of West Jetty and for dredging at Harbor of Sabine Pass, Texas, opened at New Orleans, La., October 4, 1892, by Maj. James B. Quinn, Corps of Engineers.*

| No. | Name and address of bidder. | Jetty extension. | | | Dedging. | | Remarks. |
|---|---|---|---|---|---|---|---|
| | | For 44,500 square yards brush mattress; prices bid per square yard. | For 58,000 tons of riprap stone; prices bid per ton. | Total. | For 240,000 cubic yards of dredging; prices bid per cubic yard. | Total. | |
| | | | | | *Cents.* | | |
| 1 | David V. Howell, New York, N. Y. | $1.87 | $3.37 | $278,675 | ........ | ........... | No guarantee; informal. |
| 2 | Travis L. Smith, Columbia, Tex. | .95 | 3.15 | 224,975 | ........ | ........... | Lowest bid for jetty work. |
| 3 | Frank A. Hyatt, Beaumont, Tex. | 1.87 | 4.00 | 315,215 | ........ | ........... | |
| 4 | Gustav G. Levy, Galveston, Tex. | 1.75 | 3.09 | 257,095 | ........ | ........... | |
| 5 | Chas. Clark & Co., Galveston, Tex. | 1.79 | 3.39 | 276,275 | 13½ | $32,400 | Lowest bid for dredging. |
| 6 | Rittenhouse Moore Dredging Co., by E. L. Merkel, president, Mobile, Ala. | 1.80 | 3.90 | 306,300 | 17 | 40,800 | |

Contract for jetty extension awarded to Travis L. Smith, of Columbia, Tex., and contract for dredging awarded to Charles Clarke & Co., of Galveston, Tex., with the approval of the Chief of Engineers. Contracts dated October 24, 1892, and approved November 2, 1892. Work on jetty extension contract to be completed on or before June 15, 1894, and on dredging on or before December 31, 1893.

### COMMERCIAL STATISTICS.

[From June 1, 1892, to May 31, 1893.]

| | |
|---|---|
| Vessels | 45 |
| Number of trips | 241 |
| Tonnage | 6,853 |

Draft of heaviest vessels, light, 8 feet; loaded, 14 feet 4 inches.

*Receipts and shipments for two years.*

| Articles. | Year ending May 31, 1892. | | Year ending May 31, 1893. | |
|---|---|---|---|---|
| | Tons. | Value. | Tons. | Value. |
| *Shipments.* | | | | |
| Cotton | 20 | $3,200 | ........ | ........ |
| Hides | 10 | 1,000 | ........ | ........ |
| Lumber | 23,951 | 179,632 | 9,780 | $117,060 |
| Merchandise | ........ | ........ | 450 | 22,500 |
| Total | 23,981 | 183,832 | 10,230 | 139,560 |
| *Receipts.* | | | | |
| Rock | 14,047 | 42,131 | 3,290 | 9,870 |
| Coal | ........ | ........ | 950 | 3,800 |
| Merchandise | ........ | ........ | 500 | 25,000 |
| Brick | ........ | ........ | 80 | 2,720 |
| Total | 38,028 | 225,963 | 15,050 | 180,950 |

## S 13.

## IMPROVEMENT OF SABINE RIVER, TEXAS.

A survey of the mouth of this river was made in 1871. It had a channel over the bar 3½ feet deep. In 1872-'73 the survey was extended from the mouth to Belgora, Tex. The information obtained did not warrant the expenditure of any money for improvement above Hamilton, Tex., about 247 miles above the mouth, to which point there is 3 feet depth for about three months in each year.

The estimated cost of improvement over this stretch of river by the removal of obstructions, such as logs, snags, fallen trees, etc., was $18,000.

Congress appropriated $10,000 in 1878 for the improvement, with which a channel 6 feet deep, 70 to 100 feet wide, was dredged over the bar at the mouth.

In 1879 Congress appropriated $6,000 more, and provided for a resurvey of the river from its mouth to East Hamilton.

After the survey was completed it was deemed advisable to spend this money in improving the river above Orange, and cuts were made from the main river into the Narrows and at Dead Bend.

Large numbers of sunken logs and snags were removed from the upper part of the Narrows, enabling vessels of 5 feet draft to get 30 miles above Orange.

In 1880 Congress appropriated $5,000, and in 1881 $7,000 more, for this river. The bar at the mouth had again shoaled. This was redredged in 1881-'82 to a depth of 6 feet, and a channel 100 feet wide was made a little over 1 mile in length, which still remains in fair condition.

In 1882 Congress appropriated $4,000 more for this improvement. As the river was in a sufficiently good condition for the limited commerce which it carried, this money was held for further use.

An examination in May, 1889, showed many snags and some shoal places in the part of the channel known as the Narrows, and as some $4,000 was available for work, a project was submitted for removing the snags and closing the two "Old River" branches with dams of piles, brush, and earth, to throw all the water into the Narrows.

This project was approved, the work advertised, and contrac
entered into September 20, 1889, with the Sabine Tram Comp
complete the work by December 1, 1889, for $3,647.

The smaller dam was successfully built, and most of the piles
for the larger one, when a sudden rise in the river washed out m
them. The water continued rising and remained so high that sa
tory work could not be done, so that the contract was extended
tober 30, 1890, by the Chief of Engineers. Work was resumed i
tember, 1890, and finished in December of that year, completin
project.

July 13, 1892, an appropriation of $5,000 was made for impr
Sabine River up to Sudduths Bluff, Texas.

Bids were invited for furnishing a steamboat for work unde
appropriation. Those received were not deemed advantageous t
Government, and they were rejected with the approval of the Ch
Engineers. The work was readvertised and bids were opened Ap
1893. The award of contract was made to Liles & Allardyce, of B
ville, Tex., for the best and most suitable boat at the most reaso
price.

The plant contracted for consists of a stern-wheel steamboat, w
crew of 12 men, a steam capstan, hoisting machine, etc., electric bat
fuses, and dynamite for removing obstructions from the river.

Snagging operations are to be commenced July 1, 1893, and
pleted on or before October 1, 1893.

The approved project of 1892 provides for the improvement of
river between Sabine Lake and Sudduths Bluff by the removal of s
and other obstructions, at a cost of $10,000.

It is estimated that $2,000 will be required annually to keep the r
in condition after the snags are removed.

There has been expended on the improvement of this river to Jun
1893, the sum of $34,795.04.

*Abstract of appropriations for improving Sabine River, Texas.*

| | |
|---|---|
| Allotted from act approved June 10, 1872 | $ |
| By act of Congress approved— | |
| June 18, 1878 | 1 |
| March 3, 1879 | 6 |
| June 14, 1880 | 5 |
| March 3, 1881 | 7 |
| By act of Congress— | |
| Passed August 2, 1882 | 4 |
| Approved July 13, 1892 | 5 |
| Total | 39 |

*Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $8 |
| Amount appropriated by act approved July 13, 1892 | 5,00 |
| | 5,08 |
| June 30, 1893, amount expended during fiscal year | 18 |
| July 1, 1893, balance unexpended | 4,90 |
| July 1, 1893, amount covered by uncompleted contracts | 4,50 |
| July 1, 1893, balance available | 40 |
| Amount (estimated) required for completion of existing project | 5,000 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895 | 5,000 |
| Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893. | |

*Abstract of proposals received for furnishing a steamboat for improving Sabine River, Texas, opened at New Orleans, La., April 21, 1893, by Maj. James B. Quinn, Corps of Engineers.*

| No. | Name and address of bidder. | Prices bid per day for hire of steamboat. |
|---|---|---|
| 1 | Liles & Allardyce, Burkeville, Tex | $64.70 |
| 2 | Victor Von Schoeler, Franklin, La | 97.50 |
| 3 | P. F. Nouvet, New Orleans, La | 95.00 |

Contract awarded to Liles & Allardyce, with the approval of the Chief of Engineers. Contract dated June 3, 1893, and approved June 13, 1893. Work to be commenced on July 1, 1893, and completed on or before October 1, 1893.

### COMMERCIAL STATISTICS.

[From June 1, 1892, to May 31, 1893.]

| | |
|---|---|
| Number of steamers | 9 |
| Number of trips made | 1,002 |
| Gross tonnage | 205,910 |
| Number of schooners | 29 |
| Number of trips made | 60 |
| Gross tonnage | 4,268 |
| Barges | 2 |
| Number of trips made | 8 |
| Gross tonnage | 491 |
| Total number of vessels | 40 |
| Total number of trips | 1,070 |
| Total tonnage | 210,669 |

Draft of steamers, light, 16 inches; loaded, 5 feet. Draft of schooners, loaded, 9 feet. Steamers run 510 miles above mouth of river to Logansport during high water.

*Receipts and shipments.*

| Articles. | Tons. | Value. |
|---|---|---|
| Lumber | 137,368 | $891,180 |
| Cotton | 1,750 | 227,000 |
| Cotton seed | 1,925 | 23,100 |
| Staves | 4,000 | 318,000 |
| Wool | 120 | 72,000 |
| Merchandise | 1,200 | 60,000 |
| Total | 146,363 | 1,591,280 |

## S 14.

## IMPROVEMENT OF NECHES RIVER, TEXAS.

The river was surveyed in 1872 and 1873, and resurveyed from Bevilport to its mouth.

The project for improvement contemplated the dredging of a channel over the bar at the mouth and the removal of obstructions from the river between Bevilport and Yellow Bluff.

In 1880 the bar at the mouth was dredged and a channel 5 feet deep and 30 to 60 feet wide was obtained. The obstructions in the river between Yellow Bluff and Bevilport were removed in 1882.

The original estimate of the cost of improvement was: For work a mouth of the river, $26,318.05, and for up river, $15,000, a tot $41,318.05.

The bar at the mouth of the river again shoaled until at ext low water there was a depth of about 3 feet over it.

There is very little commerce passing in and out of the river, b the bar at this place was the shoalest obstruction between the and Beaumont, Tex., and the money was available for dredging bar, it was thought advisable to reopen this channel.

The Government dredge, which had completed work at the he Calcasieu Pass; was placed in good repair and sent over to the m of the river in December, 1888, for the purpose of redredging the c nel over the bar. By the 1st of May following the dredge had rem 55,482 cubic yards of material and completed a 5-foot channel on line of the old one, of which traces still remained.

The total amount thus far expended upon the improvement of river is $28,842.16, leaving still unexpended $4,157.84.

The dredged channel can not be expected to be permanent in su broad and shallow body of water as Sabine Pass, but will prob serve all the necessities of the commerce using it for several years.

*Abstract of appropriations for improving Neches River, Texas.*

| | |
|---|---|
| By act of Congress approved— | |
| June 18, 1878 | $ |
| March 3, 1879 | |
| June 14, 1880 | |
| March 3, 1881 | |
| By act of Congress passed August 2, 1882 | |
| By act of Congress approved July 5, 1884 | |
| | 3 |

*Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $4,1 |
| July 1, 1893, balance unexpended | 4,1 |

COMMERCIAL STATISTICS.

[From June 1, 1892, to May 31, 1893.]

| | |
|---|---|
| Number of steamers | |
| Number of trips | |
| Tonnage | 31 |
| Number of schooners | |
| Number of trips | |
| Tonnage | 1 |
| Total number of steamers | |
| Total number of trips | |
| Total tonnage | 32 |

Draft of steamers, light, 14 inches; loaded, 4 feet.

Steamers run 280 miles above mouth of river to Irish Bayou.

*Receipts and shipments.*

| Articles. | Tons. | Val |
|---|---|---|
| Lumber | 75,630 | $42 |
| Cotton | 500 | 6 |
| Hides | 18 | |
| Wool | 60 | 3 |
| Cattle | 600 | 4 |
| Merchandise | 725 | 3 |
| Total | 77,533 | 60 |

The captain of one of the steamers reports that the river is being filled with deadheads, sunken logs, etc., from the sawmills to such an extent as to interfere with navigation and make it hazardous. Before, steamers could be run on a 3-foot rise; now it requires an 8-foot rise. There is complaint also of the jams from mill logs, and recently one of the steamers was detained for three months by one of these jams. The steamboat men say if such obstructions are not removed the river will soon become entirely unnavigable.

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## S 15.

### REMOVING SUNKEN VESSELS OR CRAFT OBSTRUCTING OR ENDANGERING NAVIGATION.

The two sunken coal barges in Bayou Teche, Louisiana, reported as obstructions to the navigable channel, were removed in May, 1893, without expense to the United States.

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## S 16.

### PRELIMINARY EXAMINATION OF HOMOCHITTO RIVER, MISSISSIPPI, FROM ITS MOUTH TO THE LOUISVILLE, NEW ORLEANS AND TEXAS RAILROAD BRIDGE.

[Printed in House Ex. Doc. No. 140, Fifty-second Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
*Washington, D. C., December 16, 1892.*

SIR: I have the honor to submit herewith a copy of report dated December 7, 1892, by Maj. James B. Quinn, Corps of Engineers, of the results of a preliminary examination of Homochitto River, Mississippi, from its mouth to the Louisville, New Orleans and Texas Railroad bridge, provided for by the river and harbor act approved July 13, 1892.

It is the opinion of Major Quinn that the river within the limits specified is worthy of improvement by the General Government.

The division engineer, Colonel Comstock, states, however, that in his opinion the river is not worthy of improvement, and I concur in his views.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
*Brig. Gen., Chief of Engineers.*

HON. S. B. ELKINS,
*Secretary of War.*

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### REPORT OF MAJ. JAMES B. QUINN, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
*New Orleans, La., December 7, 1892.*

GENERAL: In obedience to the requirements of letter of instructions from your office of July 14, 1892, I have the honor to submit the following report of a preliminary examination of the "Homochitto River, Mississippi, from its mouth to the Louisville, New Orleans and Tex Railroad bridge:"

Mr. P. H. Thomson, assistant engineer, was directed to make th preliminary examination, and his report is appended.

It appears that the country bordering on this river is very fertile a capable of producing a far greater amount of cotton, sugar, and oth products of the soil if the means of transportation were improved.

The river would be navigable for ordinary steamboats from its mou to the railroad crossing if the snags, overhanging trees, and raf which obstruct the channel were removed.

* * * * * * *

It is believed that were the river navigable, at least 37,455 bales cotton and 18,000 tons of cotton seed would be shipped by this rou each year, and a corresponding amount of imports in exchange. I addition to this, there would be large shipments of lumber and oth produce at present not available.

For the reasons stated, the river is, in my opinion, worthy of improv ment by the General Government within the limits specified.

No further survey is necessary.

A map* showing the locality of the river is herewith.

Respectfully submitted.

JAMES B. QUINN,
*Major, Corps of Engineers.*

Brig. Gen. THOMAS L. CASEY,
*Chief of Engineers, U. S. A.*

(Through Col. C. B. Comstock, Corps of Engineers, Division Engi neer, Southwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
SOUTHWEST DIVISION,
*New York, December 12, 1892.*

Respectfully forwarded to the Chief of Engineers.

The head waters of the Homochitto are but about 75 miles in straight line from its mouth. The Yazoo is unable to maintain s much as 3½ feet at its mouth, and the Homochitto could not maintai nearly as much.

The stream is so small that I do not think it worthy of improvement

C. B. COMSTOCK,
*Colonel of Engineers, Bvt. Brig. Gen. U. S. A.,*
*Division Engineer.*

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### REPORT OF MR. P. H. THOMSON, ASSISTANT ENGINEER.

NEW ORLEANS, LA., *November 30, 1892.*

SIR: I have the honor to submit the following report of the preliminary examination of the Homochitto River, Mississippi:

I was fortunate in obtaining data from a report of a survey made in 1849 for the Homochitto Improvement Company, which materially assisted me in making the examination. This survey embraced the entire navigable portion of the river, which extends from Meadville, in Franklin County, to the Mississippi River.

The engineer reports the distance as 180 miles, and the least depth at extreme low water at 3 feet. The stream has a minimum width of 75 feet, but there are many places in the bends where it is 200 feet. That portion above the railroad crossing is reported as practically free from obstructions.

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*Not printed.

From the railroad to the Mississippi is 110 miles. About 10 miles below the bridge occurs the first obstruction, which is some 4,000 feet in length and is caused by a jam of saw logs, which came down the river during a freshet, which burst a boom in the upper river. As there is little or no drift in the stream this raft remains sufficiently open to permit the free passage of the water in ordinary stages.

Some 10 miles further down there is another jam some 1,200 feet in length, formed at the same time and from the same cause. It is also very open and caused little obstruction to free flow of the water in ordinary stages.

About 5 miles further down the river enters the Mississippi bottoms and has had several channels. All these are now closed with the exception of Coulsons Bayou. This bayou has a width of from 60 to 90 feet, a depth of 8 feet, and is much obstructed by snags, logs, and overhanging trees. It is about 5 miles long.

From the mouth of Coulsons Bayou to the Mississippi the Homochitto is from 70 to 150 feet in width, has a least depth of 8 feet, and is obstructed by snags and logs. It passes through Ellis Lake and Old River, which present no obstacles. The 5 miles near the Mississippi is called The Narrows, and has abundance of water until the bar is reached, where the least depth is 3½ feet.

As the portion of the river below Coulsons Bayou is in the Mississippi Bottom, and this portion of the river is not protected by levees, in time of flood the currents run directly across the Homochitto and have caused a gradual filling up of the lakes and bayous.

There are outlets into the Buffalo River, a stream which follows the bluff and empties into the Mississippi some 5 miles below the mouth of the Homochitto, and should the latter be improved it would be well to take one of these outlets and open it. The bar at the mouth of Buffalo River has 3½ feet on it at low water.

## STATISTICS.

These have been very carefully compiled in detail by several gentlemen interested in the improvement, embracing the country on each side of the Homochitto for a distance back from the river of about 5 miles and are entitled to full credit. They are not complete, but I give them as received:

| | |
|---|---|
| Exports: | |
| 37,455 bales cotton, at $50 | $1,872,750 |
| 18,000 tons cotton seed, at $10 | 180,000 |
| Total | 2,052,750 |
| Value of supplies received (collating all the various estimates) | 1,436,925 |
| Total probable business | 3,489,675 |

The demand for this improvement arises from the fact that all the tributaries of the Homochitto enter it at nearly right angles, and the ridges between rise very precipitously to a height of 150 feet, making transportation of crops and supplies to and from either the railroad or the Mississippi River both difficult and expensive.

There are large bodies of timber lands adjacent to the Homochitto covered with a heavy growth of long-leaf pine, white oak, elm, hickory, magnolia, and other woods which would be utilized if the river was improved.

* * * * * * *

This stream is eminently worthy of improvement as it would open an extremely fertile and well-settled country for 180 miles which is now practically destitute of commercial facilities.

No further survey is needed until an appropriation is made.

Very respectfully,

P. H. THOMSON,
*Assistant Engineer.*

Maj. JAMES B. QUINN,
*Corps of Engineers.*

## S 17.

## PRELIMINARY EXAMINATION FOR HARBOR OF REFUGE ON LAKE PO CHARTRAIN, LOUISIANA, MOST SUITABLE POINT AT OR NEAR ENTRAN INTO THE OLD AND NEW BASINS.

[Printed in House Ex. Doc. No. 138, Fifty-second Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
*Washington, D. C., December 15, 189*

SIR: I have the honor to submit the accompanying copy of rep dated December 10, 1892, by Maj. Jas. B. Quinn, Corps of Engineers the results of a preliminary examination for harbor of refuge on L Pontchartrain, Louisiana, most suitable point at or near entrance i the old and new basins, provided for by the river and harbor act proved July 13, 1892.

It is the opinion of Major Quinn, concurred in by the division en neer and by this office, that the locality is worthy of improvement the General Government.

No survey is necessary at this time.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
*Brig. Gen., Chief of Engineers*

HON. S. B. ELKINS,
*Secretary of War.*

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### REPORT OF MAJ. JAMES B. QUINN, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
*New Orleans, La., December 10, 1892*

GENERAL: I have the honor to submit the following prelimin report upon a "harbor of refuge on Lake Pontchartrain, Louisia most suitable point at or near entrance into the old and new basin in pursuance with instructions contained in letter from the office of Chief of Engineers, U. S. Army, dated July 14, 1892:

Two canals lead from Lake Pontchartrain to the heart of the city New Orleans. About all the commerce upon the lake traverses th canals, and it is of general importance to the shipping of the lake t the entrances to the canals be safe under all conditions of weath Such is not the case now.

In stormy weather vessels are obliged to seek shelter elsewhere th in the vicinity of the canal entrances, or anchor in an exposed situat in dangerous proximity to the shore.

The entrances are not far apart, and if a breakwater were construc in the lake in proximity to them, so that vessels would have a sec anchorage during stormy weather, it would be of great service to shipping seeking the New Orleans markets.

In considering the best location for such a structure it is to be obser that the strongest gales come from the northwest, and it is appar that if a breakwater is built so as to afford partial protection to windward canal entrance it will also afford partial protection to sh ping seeking the other canal entrance.

In considering the importance of these canals it is to be observed that the new canal, the most westerly of the two, is the most important. This information is embodied in the accompanying letter upon this subject from Mr. Robert S. Day, to which further attention is invited for information concerning the commercial statistics and other important information, which from personal investigations I am able to fully indorse.

A breakwater off the entrance to the new canal would meet the requisites of a harbor of refuge in Lake Pontchartrain.

* * * * * * *

The commercial interests involved are important, and the harbor is, in my opinion, worthy of improvement by the General Government.

No further survey is necessary.

Respectfully submitted.

JAMES B. QUINN,
*Major, Corps of Engineers.*

Brig. Gen. THOMAS L. CASEY,
*Chief of Engineers, U. S. A.*

(Through Col. C. B. Comstock, Corps of Engineers, Division Engineer, Southwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
SOUTHWEST DIVISION,
*New York, December 13, 1892.*

Respectfully forwarded to the Chief of Engineers.

For the reasons stated by Major Quinn I concur in his opinion that this place is worthy of improvement.

C. B. COMSTOCK,
*Colonel of Engineers, Bvt. Brig. Gen., U. S. A.,*
*Division Engineer.*

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### LETTER OF MR. ROBERT S. DAY.

DEAR SIR: Your memorandum has been referred to me by Mr. Lagan as having posted myself on the subject, and, while I have not all the figures, I beg to send you the following as approaching the traffic of the canals. The new canal does fully three-quarters of the business, and this is not due to any fault in the construction of the old canal, but simply because there is not sufficient room or ground around its basin or head to facilitate the traffic. The new canal has a great deal of ground for the building interests, etc., and consequently has the bulk of the traffic.

The memorandum I send you below of the traffic on Lake Pontchartrain will give you the details on which I made application to Congress on behalf of the schooner owners on the lake.

### SHIPPING ON LAKE PONTCHARTRAIN.

Shipping engaged in coast trading is about as follows: There are four steamers aggregating 600 tons. The largest, the *New Camelia,* carried last year 3,500,000 pounds of feed stuffs and groceries, etc., and brought back produce to the extent of 1,700,000 pounds, and during the year carried 24,000 passengers. The other four steamers plying in tributary streams and Lake Maurepas I am unable to get the details of. There are also six large-sized tugs doing business in these waters. The average number of sailing coasters that come into the two canals is twelve a day the year around, and while these vessels are comparatively small, on account of the shoal water, their aggregate tonnage will amount to over 5,000 tons. Besides this, pleasure crafts, consisting of five steam yachts and twenty-five sailing yachts, make use of the canals as harbors, there being no harbor in the lake.

Besides this traffic above mentioned, there are many vessels plying between po in the lake and adjoining bodies of water that do not come to the canals at all. produce brought in via the canals during the year of 1890, as far as I can trac is about as follows:

| | | |
|---|---|---|
| Lumber (valued at $15 per M) | feet.. | 70,000, |
| Bricks (valued at $8 per M) | M.. | 5,000, |
| Shells (at 25 cents per barrel) | barrels.. | 30, |
| Sand (at 25 cents per barrel) | do.... | 300, |
| Timber (at 7 cents per running foot) | feet.. | 4,000, |
| Staves, cypress and oak (at 6 cents per piece) | pieces.. | 6,000, |
| Laths (at $1.50 per M) | M.. | 2,000, |
| Shingles (at $3 per bundle) | bundles.. | 4,000, |

Cotton, 5,000 bales reported to the cotton exchange for the year 1890; this i alone representing a value of $200,000. The item of lumber, exclusive of timl represents a value of $1,000,000 and over, while the timber brought in is value $300,000.

From these figures a correct idea of the importance of the trade may be gair It is frequently the case now to see forty or fifty schooners jammed in the mou of the canals, for the want of a harbor, almost blocking the entrance to storm-dri vessels.

From the above you will see that the trade is somewhere in the neighborhood $2,500,000, and of this fully $1,800,000 comes in by way of the new canal, and it i the mouth of this canal that the numerous wrecks have taken place.

Last summer three vessels were wrecked right at the mouth of the canal, notwi standing that it is well marked with double lights, buildings, etc. The year bef two wrecks occurred, and on the 5th of May, 1891 a sudden storm from the northe of the lake brought over twenty schooners to anchor to ride out the storm, beca there was no harbor to make, and three of them were wrecked, one being swamp one blown over, and the other losing her mast, not one daring to come into the car The jetties at the Bayou St. John or old canal are built into much deeper water, ow to the conformation of the bed of the lake, and consequently there is not so m danger from rollers.

The water around the mouth of the new canal is shoal for a considerable dista out, and as the rollers take possession of a schooner within 200 feet of the entra they become almost unmanageable.

In view of this fact and the large preponderance of the traffic going into the n canal, it is the opinion of the schooner owners, to whom I have talked on the subj that a breakwater would be more advantageous if located at the mouth of the n canal. Of course a breakwater located anywhere would be advantageous, eve midway between the St. John Canal and the new canal, and no matter where loca will be a harbor for which storm-driven vessels can make. But it seems to me t the harbor should be so constructed where it will do the greatest good and accom date the great amount of traffic, namely, at the mouth of the new canal, and wh it would be quite as convenient to all other points as it would be 2 or 3 miles to eastward.

The particular reason for a breakwater at the mouth of the canal, as I said in petition to Congress, which was signed by about three hundred names of schooner owners, and indorsed by all the commercial bodies of the city, is t there is no harbor at all on the south shore of the lake for vessels, and that so times forty or fifty schooners are jammed into the mouth of the canal awaiting opportunity to go out, when only a moderate gale is blowing, and thereby preve ing vessels that are outside from coming in. You can understand that, with crowded mouth of the canal, a vessel coming in under full steerage way has a rat desperate time of finding room to slow up and check her way.

If there is any other information that I can give you I shall be delighted to be service to you, and sincerely trust that you will be able to get a favorable report your survey.

Yours truly,

ROBERT S. DAY

Maj. JAMES B. QUINN,
*U. S. Engineer Office.*

## S 18.

### PRELIMINARY EXAMINATION OF BAYOUS BLACK AND TERREBONNE, WITH A VIEW OF CONNECTING THEM BETWEEN SOUTHDOWN PLANTATION AND HOUMA, LA., AND OPENING A SHORTER AND SAFER INLAND WATER ROUTE FROM THE MISSISSIPPI VALLEY, VIA BERWICKS BAY, TO TEXAS AND MEXICO.

[Printed in House Ex. Doc. No. 158, Fifty-second Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
*Washington, D. C., December 22, 1892.*

SIR: I have the honor to submit the accompanying copy of report, dated December 16, 1892, by Maj. James B. Quinn, Corps of Engineers, of the results of a preliminary examination of "bayous Black and Terrebonne, with a view of connecting them between Southdown Plantation and Houma, La., and opening a shorter and safer inland water route from the Mississippi Valley, via Berwicks Bay, to Texas and Mexico," made to comply with provisions of the river and harbor act approved July 13, 1892.

Major Quinn remarks that "the portion of this route included in the limits of the present preliminary examination could hardly be considered in a separate view as important, since it is essentially a portion and possesses value only as a connecting link in the system of tide-water canals extending from the Mississippi River to Berwicks Bay and beyond," and unless the entire system of canals, of which the bayous Black and Terrebonne are but connecting links, is considered, the canal connecting them is not, in his opinion, worthy of improvement by the General Government.

In forwarding the report of Major Quinn to this office the division engineer states that for the reasons given he does not think this place worthy of improvement by the United States, and I concur in his views.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
*Brig. Gen., Chief of Engineers.*

Hon. S. B. ELKINS,
*Secretary of War.*

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### REPORT OF MAJ. JAMES B. QUINN, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
*New Orleans, La., December 16, 1892.*

GENERAL: As directed by letter from your office of July 14, 1892, I have the honor to submit the following report of a preliminary examination of "bayous Black and Terrebonne, with a view of connecting them between Southdown Plantation and Houma, La., and opening a shorter and safer inland water route from the Mississippi Valley, via Berwicks Bay, to Texas and Mexico."

The southern portion of Louisiana posesses peculiar advantages for the construction of tide-water canals, it being possible to construct one from the eastern to the western boundary extending in almost a direct line between the two points. In fact, such a canal, or system of canals, is in partial existence at this date, and previous to the construction of railroads was in very general use. Owing, however, to various causes, the portion between the Mississippi River and the Atchafalaya has deteriorated greatly, and although the commercial advantages of its reëstablishment are generally recognized, the expense of reconstruction is beyond the means of private enterprise.

The portion of this route included in the limits of the present preliminary examination could hardly be considered in a separate view as important, since it is essentially a portion and possesses value only as a connecting link in the system of tide-water canals extending from the Mississippi River to Berwicks Bay and beyond.

Over the portion covered by the examination there is at present an inconsiderable commerce; and it is simply a matter of conjecture as to what this commerce would be were the system of canals reconstructed. The value of this commerce is estimated at about $9,450,000 annually.

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Unless the entire system of canals, of which the bayous Black and Terrebonne are but connecting links, is considered, the canal connecting them is not, in my opinion, worthy of improvement by the General Government.

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Mr. P. H. Thomson, assistant engineer, made the preliminary examination, and his report is appended.

Respectfully submitted.

JAMES B. QUINN,
*Major, Corps of Engineers.*

Brig. Gen. THOMAS L. CASEY,
*Chief of Engineers, U. S. A.*

(Through Col. C. B. Comstock, Corps of Engineers, Division Engineer, Southwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
SOUTHWEST DIVISION,
*New York, December 21, 1892.*

Respectfully forwarded to the Chief of Engineers.

For the reasons stated by the district engineer I do not think this place worthy of improvement by the United States.

C. B. COMSTOCK,
*Colonel of Engineers, Bvt. Brig. Gen., U. S. A.,*
*Division Engineer.*

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### REPORT OF MR. P. H. THOMSON, ASSISTANT ENGINEER.

NEW ORLEANS, LA., *December 12, 1892.*

SIR: I have the honor to submit the following report of the examination of "bayous Black and Terrebonne, with a view of connecting them between Southdown Plantation and Houma, La., and opening a shorter and safer inland water route from the Mississippi Valley, via Berwicks Bay, to Texas and Mexico."

The object for which this examination is asked is the reopening of a water route which was in use prior to 1860, and which, if properly reconstructed, would control the high rates now charged by rail on all the commerce of southwestern Louisiana.

The work was done originally by the Barataria Canal Company, a corporation chartered by the State of Louisiana in 1829, and was opened for business before 1840. It may be described as follows:

The canal leaves the Mississippi River by a lock at a point opposite New Orleans and runs very directly to Lake Salvador, a distance of 9 miles. This portion is from 40 to 70 feet wide, with a least depth of 6 feet at mean low tide. The route passes through Lake Salvador and up Bayou des Allemands for 17 miles, having in no place a depth of less than 8 feet.

From Bayou des Allemands to Bayou Lafourche, 12 miles, through a canal with a width of 70 feet—6 miles of this portion has a least depth of 6 feet, the remaining 6 miles, having fallen into disuse, is much obstructed by grass and has in places not more than 3 feet of water.

At Bayou Lafourche it was intended to construct two locks of precisely the same dimensions as the one on the Mississippi. But one of these was built, however, and it, after being in use for several years, was destroyed by a crevasse and has never been replaced. While the lock was standing, however, it was much used, not only by those living on Bayou Lafourche but also by planters from the west, who transferred their freights across the levee on the west bank.

Leaving Bayou Lafourche, the canal was constructed to and through lakes Field and Long to the Terrebonne, up which the route passed to Houma and thence by a canal to Bayou Black. Timber locks were built below Houma on Bayou Terrebonne at each end of the canal connecting with Bayou Black, and one in the latter some distance below the canal.

No effort was made to excavate these bayous or canals below tide level, and the destruction of the locks and consequent drainage has caused the bayous to appear as though they had become filled with sediment, when really it is only the original bottom of the stream which is disclosed.

The distance from Bayou Lafourche to Houma is 15 miles; canal connecting with Bayou Black, 1 mile; from canal to deep and open water in Bayou Black, 14¼ miles, and thence by deep and wide bayous to Berwicks Bay, 27 miles, making total distance from New Orleans to Berwicks Bay by this route 95¼ miles.

The shortest water route at present available between these points is via the Mississippi to Old River, thence down the Atchafalaya a distance, according to surveys on file in this office, of 338 miles.

By the proposed Plaquemine route the distance would be 136 miles.

*Comparative distances from New Orleans to Berwicks Bay.*

| | Miles. |
|---|---|
| Via Houma route | 95¼ |
| Via Plaquemine | 136 |
| Via Old River and Atchafalaya | 338 |
| The distance to mouth of Red River via Houma and Berwicks Bay | 227 |
| Via Mississippi and Old River | 202 |
| Distance from New Orleans to Berwicks Bay by Southern Pacific Railroad | 80 |

STATISTICS.

If this route were opened and the locks, which are now only large enough to pass boats of 125 feet length and 24 feet beam, enlarged to capacity to pass the steamers engaged in the Teche and Vermilion trade, the commerce of the parishes interested can be conservatively estimated as follows:

| | |
|---|---|
| Lafourche | $3,500,000 |
| Terrebonne | 1,450,000 |
| St. Mary, Iberia, and St. Martin | 3,000,000 |
| Vermillion | 1,500,000 |
| Total | 9,450,000 |

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Very respectfully,

P. H. THOMSON,
*Assistant Engineer.*

Maj. JAMES B. QUINN,
*Corps of Engineers.*

## S 19.

## PRELIMINARY EXAMINATION OF SABINE RIVER FROM SUDDUTHS BLU TEXAS, TO LOGANSPORT, LA.

[Printed in House Ex. Doc. No. 139, Fifty-second Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
*Washington, D. C., December 16, 1892*

SIR: I have the honor to submit the accompanying copy of repo dated December 8, 1892, by Maj. James B. Quinn, Corps of Enginee of the results of a preliminary examination of Sabine River, from S duths Bluff, Texas, to Logansport, La., provided for by the river a harbor act approved July 13, 1892.

It is the opinion of Major Quinn, concurred in by the division en neer and by this office, that the river within the limits named is n worthy of improvement by the General Government.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
*Brig. Gen., Chief of Engineers.*

Hon. S. B. ELKINS,
*Secretary of War.*

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## REPORT OF MAJ. JAMES B. QUINN, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
*New Orleans, La., December 8, 1892.*

GENERAL: In compliance with the requirements of letter from t office of the Chief of Engineers, dated July 14, 1892, I have the hon to report as follows regarding a preliminary examination of Sabi River from Logansport, La., to Sudduths Bluff, Texas:

This preliminary examination was made by Mr. P. H. Thomson, who report is appended.

It appears that the Sabine River is not navigable except at very hig stages above Hamilton, a distance of 54¼ miles below Loganspor owing to the existence of shoals and bars. The river below Hamilto is obstructed with shoal bars and snags which prevent navigation f more than three or four months in the year. The country bordering t river is fertile, and would be brought under cultivation did suitab facilities for getting the produce to market exist.

The improvement of the river would supply this latter requisite, b it is to be observed that a suitable system of improvement would be rather an expensive character; the mere removal of snags and suc temporary obstructions would be of little use and of temporary natur

The river is adapted to the method of improvement by means of lock and dams, but since such a system would cost over $3,000,000 it is n believed that the present conditions would warrant such an expenditur

It is difficult to determine just what future developments of the regio tributary to this river will require in the way of water transportatio later on, but just at present it does not appear that the river betwee Logansport and Sudduths Bluff is worthy of improvement.

The commercial statistics, such as it has been possible to obtain, may be found in Mr. Thomson's report.

Respectfully submitted.

JAMES B. QUINN,
*Major, Corps of Engineers.*

Brig. Gen. THOMAS L. CASEY,
*Chief of Engineers, U. S. A.*

(Through Col. C. B. Comstock, Corps of Engineers, Division Engineer, Southwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
SOUTHWEST DIVISION,
*New York, December 12, 1892.*

Respectfully forwarded to the Chief of Engineers.

For the reasons stated by the local engineer I do not think the Sabine River from Logansport, La., to Sudduths Bluff, Texas, worthy of improvement at present.

C. B. COMSTOCK,
*Col. of Engrs., Bvt. Brig. Gen., U. S. A.,*
*Division Engineer.*

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### REPORT OF MR. P. H. THOMSON, ASSISTANT ENGINEER.

NEW ORLEANS, LA., *November 30, 1892.*

SIR: I have the honor to submit the following report of the examination of Sabine River from Logansport, La., to Sudduths Bluff, Texas.

Much of the information embodied in this report has been obtained from reports and maps of surveys made in 1873 and 1879 under the direction of Maj. C.W. Howell, Corps of Engineers, and from the official reports made by the bureaus of agriculture of the States of Texas and Louisiana.

#### GENERAL DESCRIPTION.

The Sabine River from Logansport to the point where it enters the sea marsh flows in an alluvial valley which has a width of from 4 to 5 miles.

The river itself at Logansport is only 100 feet wide and maintains that width as far down as Hamilton, thence gradually widening until at Sudduths Bluff it is 175 feet.

The distance from Logansport to Sudduths Bluff is 239¾ miles.

The banks are generally from 5 to 10 feet in height, but where the stream touches on either side of the valley, there are bluffs which frequently attain an elevation of 60 to 100 feet. From Burrs Ferry to Logansport these bluffs are composed of sandstone or conglomerate.

From Logansport to Burrs Ferry, a distance of 136¼ miles, it is a succession of pools and rapids, the latter formed by ledges of sandstone, lignite, and limonite.

The depth of this part of the river varies from a few inches, on the rapids, to 10 feet in the pools.

From Burrs Ferry to Sudduths Bluff the river is obstructed with shoals composed of gravel and sand, the low-water depth varying from 2 to 30 feet.

Navigation for boats drawing not more than 3 feet can be depended upon as far up as Hamilton 54½ miles below Logansport, for three or four months in the year.

The river is obstructed for its entire length by snags and overhanging trees.

There are no large tributaries, and although there are many overflowing creeks, they do not add much to the water supply, which latter is mainly derived from the northern portion of Texas.

#### STATISTICS.

The portion of the country dependent upon the Sabine for their means of reaching a market is generally heavily timbered with a growth of long-leaf pine, cypress, oak, walnut, hickory, ash, and beech.

The soil varies from the black alluvion of the bottoms to stiff, red clay on the hills, but is for the most part a sandy loam, producing, when cultivated, large crops of cotton, corn, cane, rice, oats, potatoes, etc.

The population of the countries and parishes adjacent to the river by the latest official reports is 90,355.

The value of the crops as reported by the bureaus of agriculture of the States of Texas and Louisiana for the year 1891 amounted to $3,875,877. This does not include the value of cattle, sheep, and hogs, nor the value of the logs floated down the river. The latter amounted in the year ending May 1, 1892, according to report of chamber of commerce, of Orange, Tex., to 89,681,500 feet B. M., which at $6 per thousand feet would be $538,089, making total marketable products, exclusive of cattle, hogs, etc., $4,413,966.

Logs are floated from all parts of the river up as high as Hamilton.

By the official returns the total number of acres of timber land adjacent to the river and dependent upon it for an outlet is 4,852,292, mostly covered with timber of great value.

The mineral resources are to a large extent unknown, but lignite of good quality, sandstone, and iron have been found in large bodies. The iron is very pure, and the report of the State geologist of Texas states that the area of ore-bearing district of east Texas amounts to 1,000 square miles. The river has cut through these formations at several points.

Sandstone of good quality and sand can be found at many points, so that building materials for the improvements is readily available.

### IMPROVEMENT.

It is apparent from the above that the only practicable means to secure permanent navigation between Logansport, La., and Sudduths Bluff, Texas, is by the construction of locks and dams.

That there is an ample supply of water is beyond a doubt, as the discharge of the river at extreme low water amounts to fully 600 cubic feet per second, which would afford twenty lockages per hour for locks of the size determined upon. Unfortunately the surveys have not included levels, and the estimate of the number of locks and dams must be based upon the total fall of the river from Logansport to mean low tide in the Gulf of Mexico. For this information I am indebted to Mr. M. G. Howe, general manager of the Houston and Shreveport Railroad, who gives the elevation of the bed of the river at Logansport at 125 feet above mean low water at Houston, Tex.

Locks adapted to the Sabine should have a chamber 175 feet by 50 feet in the clear and the lift should be 12 feet.

On that portion of the stream from Logansport to Burrs Ferry, good building stone and sand are abundant.

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Very respectfully,

P. H. THOMSON,
*Assistant Engineer.*

Maj. JAMES B. QUINN,
*Corps of Engineers.*

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## S 20.

## PRELIMINARY EXAMINATION OF CHANNEL THROUGH SABINE LAKE FROM SABINE PASS TO MOUTHS OF SABINE AND NECHES RIVERS, TEXAS.

[Printed in House Ex. Doc. No. 146, Fifty-second Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
*Washington, D. C., December 17, 1892.*

SIR: I have the honor to submit the accompanying copy of report, dated December 10, 1892, by Maj. James B. Quinn, Corps of Engineers, of the results of a preliminary examination of channel through Sabine Lake from Sabine Pass to mouths of Sabine and Neches rivers, Texas, made to comply with provisions of the river and harbor act approved July 13, 1892.

It is the opinion of Major Quinn that, for reasons stated, a channel through Sabine Lake is worthy of improvement by the General Government, and he submits an estimate of $2,500 as the cost of survey necessary to preparation of plan of improvement.

The division engineer, in submitting the accompanying report, remarks that he thinks the channel through Sabine Lake is, in some degree, worthy of improvement, and I concur in his views.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
*Brig. Gen., Chief of Engineers.*

Hon. S. B. ELKINS,
*Secretary of War.*

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## REPORT OF MAJ. JAMES B. QUINN, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
*New Orleans, La., December 10, 1892.*

GENERAL: In obedience with the requirements of a letter from the office of the Chief of Engineers, U. S. Army, dated July 14, 1892, I have the honor to make the following report of a preliminary examination of "channel through Sabine Lake from Sabine Pass to mouths of Sabine and Neches rivers, Texas."

This lake is part of the water route from the deep waters of the Sabine and Neches rivers to Sabine Pass on the Gulf of Mexico, and is in general too shoal to permit the passage of vessels of such draft as could navigate safely the rivers or the pass.

The flattering results attending the improvements at Sabine Pass prompt the early consideration of the extension of this deep-water navigation to the rivers tributary to Sabine Lake, and so joining the water transportation to the already existing railroad system and thereby establishing a most advantageous commercial arrangement for the development of a large area of very rich country.

The resources of the country tributary to the Sabine and Neches rivers are very great. The quantity of merchantable lumber is estimated at 90,000,000,000 feet, or say 180,000,000 tons, which, at the low price of $1.50 per 1,000 feet for stumpage, would represent a value of $135,000,000, or if manufactured into lumber, fully ten times as great a value. The mineral resources are very great, but for lack of cheap transportation have not been developed.

The agricultural products are increasing in value day by day, and, notwithstanding the difficulties in the way of easy access to market, have already reached a respectable magnitude. As much of the value of such products depends upon easy access to tide water, anything which may be done to facilitate the water transportation will result in a great saving to the producers and greatly benefit the country.

It does not seem to me necessary to enter into any elaborate exhibit of statistics at this time, since much of this information is already embodied in official reports; but as a matter of interest I will add that the estimated annual output of lumber in the district tributary to Sabine Pass is placed at 4,554,000 tons by the board of trade of Orange, Tex., and the lumber exchange of Beaumont, Tex.

If the small reduction of 2 cents per hundred pounds in freight rates upon this single product could be secured through the improvement of the water transportation it would amount to $1,621,840, a saving in one year of probably sufficient to complete the deep-water connection between Sabine Pass and the mouths of Sabine and Necl rivers.

For the foregoing reasons a channel through Sabine Lake is, in opinion, worthy of improvement by the General Government.

A detailed survey will be neccessary before precise estimates of t cost of the improvement can be given. This survey would cost $2,5

The preliminary examination was made by Mr. J. L. Brownlee, sistant engineer, and his report is appended.

Respectfully submitted.

JAMES B. QUINN,
*Major, Corps of Engineers.*

Brig. Gen. THOMAS L. CASEY,
*Chief of Engineers, U. S. A.*

(Through Col. C. B. Comstock, Corps of Engineers, Division En neer, Southwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
SOUTHWEST DIVISION,
*New York, December 15, 1892.*

Respectfully forwarded to the Chief of Engineers.

For the reasons stated by Major Quinn, I think the channel throu Sabine Lake in some degree worthy of improvement.

C. B. COMSTOCK,
*Colonel of Engineers, Bvt. Brig. Gen., U. S. A.,*
*Division Engineer.*

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## REPORT OF MR. J. L. BROWNLEE, ASSISTANT ENGINEER.

NEW ORLEANS, LA., *September 30, 1892.*

MAJOR: Pursuant to verbal instructions I have made a preliminary examinati of Sabine Lake, Texas, and have the honor to submit the following report:

Sabine Lake is a part of the boundary line between Louisiana and Texas, and situated at the head of Sabine Pass, Texas. The distance from the head of Sabi Pass across the lake to the mouths of the Sabine and Neches rivers is about 18 mile with an average depth of about 7 feet, excepting on the bars at Blue Buck Point, the head of Sabine Pass, and the mouths of Sabine and Neches rivers, where shoals to from 4½ to 5 feet.

The importance of improving this lake can be seen by quoting from the report the Orange board of trade. In speaking of the lumber resources of that portion Texas tributary to Sabine Pass, and consequently tributary to Sabine Lake, th say: "The area of the pineries, both long and short leaved, is estimated at 25,000,0 acres, capable of producing 64,587,420,000 feet of merchantable lumber." This stat ment is supported by the commissioner of agriculture of the State of Texas.

The United States Forestry Report, issued by the Census Bureau, says that i Texas and Louisiana there are at least 8,000,000,000 feet of long-leaf pine which ca be more cheaply conveyed to the mills on the Sabine than any other market. Th waterway through Sabine Lake and Pass would be the most economical route f shipping this lumber.

Besides the lumber resources there is a very rich agricultural country tributary Sabine Lake. During the fiscal year ending June 30, 1892, there was shipped fro Orange, Tex., alone, through Sabine Lake, over $1,250,000 worth of lumber, abou 104,000 tons.

The improvement of Sabine Pass, Texas, will give a depth of 20 feet from the Gu to Sabine Lake. If this improvement could be extended through Sabine Lake to th mouths of the Sabine and Neches rivers it would give a deep-water connection fro the Gulf to the railroads at Orange, Tex., and Beaumont, Tex., and would give a outlet for this vast amount of lumber.

From the amount of lumber shipped through Sabine Lake with its present dept and from the increase that would naturally follow any improvement that would b made, and in view of the prospects of deep water at Sabine Pass, in my judgment it is eminently worthy of improvement.

A complete survey of Sabine Lake with reference to its improvement would cost $2,500.

Very respectfully, your obedient servant,

J. L. BROWNLEE,
*Assistant Engineer.*

Maj. JAMES B. QUINN,
*Corps of Engineers.*

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## S 21.

### PRELIMINARY EXAMINATION FROM THE MOUTH OF NECHES RIVER, TEXAS, TO SHOOKS BLUFF.

[Printed in House Ex. Doc. No. 156, Fifty-second Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
*Washington, D. C., December 28, 1892.*

SIR: I have the honor to submit the accompanying copy of report, dated December 22, 1892, by Maj. James B. Quinn, Corps of Engineers, of the results of a preliminary examination of Neches River, Texas, from its mouth to Shooks Bluff, made to comply with requirements of the river and harbor act approved July 13, 1892.

Major Quinn expresses the opinion that this river, from its junction with the Angelina River to the mouth, is worthy of improvement by the General Government.

The Division Engineer, Colonel Comstock, in forwarding Major Quinn's report, expresses the opinion that up to the junction of the Angelina, Neches River is worthy of improvement by removal of snags and overhanging trees, and I concur in his views.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
*Brig. Gen., Chief of Engineers.*

Hon. S. B. ELKINS,
*Secretary of War.*

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### REPORT OF MAJ. JAMES B. QUINN, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
*New Orleans, La., December 22, 1892.*

GENERAL: In pursuance with the instructions contained in letter from the office of the Chief of Engineers, dated July 14, 1892, I have the honor to submit the following report upon a preliminary examination of the Neches River, Texas, from the mouth to Shooks Bluff:

Mr. P. H. Thomson, assistant engineer, made this examination and his report is appended.

It will be observed that for a distance of 51 miles the river requires no improvement, but beyond this point to the junction of the Angelina, a distance of about 106 miles, the channel is obstructed with snags and impending trees. Beyond the junction of the Neches and Angelina the river is not capable of improvement except at a cost beyond that warranted by the present or prospective interests to be accommodated.

The prosperity of the country from the junction of the Neches Angelina Rivers to the mouth of the Neches River would be grea advanced by the improvement of this portion of the Neches so as afford water transportation during the period of low water.

The lumbering interest of Beaumont, Tex., amounts to considera value, the annual output of lumber being in the neighborhood 75,000,000 feet.

The cotton shipments by river amount to about 7,000 bales annua and the supplies shipped in return will probably exceed in weight shipments of cotton. It is to be regretted that no precise statis can be obtained, but it is my belief that the improvement of the Nec from the junction with the Angelina River to the mouth is worth being done by the General Government.

* * * * * * *

No further survey is needed.

Respectfully submitted.

JAMES B. QUINN,
*Major, Corps of Engineers*

Brig. Gen. THOMAS L. CASEY,
*Chief of Engineers, U. S. A.*

(Through Col. C. B. Comstock, Corps of Engineers, Division En neer, Southwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
SOUTHWEST DIVISION,
*New York, December 27, 1892*

Respectfully forwarded to the Chief of Engineers.

I concur with the district engineer in the opinion that up to the ju tion of the Angelina this river is worthy of improvement by remo of snags and overhanging trees.

C. B. COMSTOCK,
*Colonel of Engineers, Bvt. Brig. Gen. U. S. A.,*
*Division Engineer*

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### REPORT OF MR. P. H. THOMSON, ASSISTANT ENGINEER.

NEW ORLEANS, LA., *December, 19, 189*

SIR: I have the honor to submit the following report of my examination of Neches River, Texas, from the mouth to Shooks Bluff.

At the mouth the river is about 1,000 feet wide and very deep. It gradually creases in width and depth to Weiss Bluff, 51 miles, and has an available depth low water to that point of 3 feet, with an average width of 150 feet.

The influence of the tides is felt as far as Weiss Bluff.

This portion of the river is not much obstructed, being kept comparatively cl by the mill men of Beaumont.

Above Weiss Bluff the river is only navigable during high water, which usua prevails from December to March.

The portion of the river between Weiss Bluff and the mouth of the Angelina, miles, is very crooked, has a width generally of 150 feet, and varies in depth fr 1 to 15 feet. It is much obstructed by snags and overhanging timber.

From the mouth of the Angelina to Shooks Bluff, a distance, probably, of miles, the Neches River is in no sense a navigable stream, nor can it be made so reasonable cost, being obstructed by rocky shoals and very narrow.

There are no interests involved which can not be better served by the railw already built and building.

The only interests which are to be promoted by the improvement of the Neches River are the lumber interests of Beaumont, amounting to 75,000,000 feet annually, and the agricultural interests of the counties of Jasper, Tyler, Angelina, and San Augustine.

According to Report of Bureau of Agriculture of the State of Texas, these counties produced during the season of 1890–'91, 13,330 bales of cotton, of which possibly one-half was shipped to market by the Neches River.

* * * * * * *

Undoubtedly if the river was opened to the junction with the Angelina River, so as to be navigable at low water, which is the season for shipping the crops and receiving supplies, the commerce of the river would be largely increased. As it is, the value of the various articles transported annually amounts to more than $1,000,000, and would justify the expenditure involved.

* * * * * * *

Two surveys of this river have already been made, one in 1873 and the other in 1880, and no further survey is required.

Very respectfully,

P. H. Thomson,
*Assistant Engineer.*

Maj. James B. Quinn,
*Corps of Engineers*

# APPENDIX T.

## SECURING MOUTH OF BAYOU PLAQUEMINE, LOUISIANA, FROM FURTHER CAVING.

### *REPORT OF CAPT. JOHN MILLIS, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1893.*

UNITED STATES ENGINEER OFFICE,
*New Orleans, La., June 30, 1893.*

GENERAL: I have the honor to submit the following report upon the works in charge of this office under the Chief of Engineers, U. S. Army, for the year ending June 30, 1893:

### SECURING MOUTH OF BAYOU PLAQUEMINE, LOUISIANA, FROM FURTHER CAVING.

This bayou was formerly an outflowing branch of the Mississippi River. It left the river at the town of Plaquemine, La., and after a course of about 10 miles began to branch off or divide into an intricate network of bayous, the whole system connecting with the Atchafalaya and Grand rivers and with Grand Lake.

While the bayou remained connected with the Mississippi it was leveed on both sides for some distance down. In 1865 the levee system on the west bank of the Mississippi was carried directly across the head of the bayou, cutting it off from all communication with the Mississippi and terminating its functions as an outlet. The bayou, being deprived of a direct supply of water from the Mississippi, now depends on water from Grand Lake and the connecting rivers and bayous, and in low water it becomes very shoal and nearly or quite dry towards the head.

By the river and harbor act of August 11, 1888, an appropriation was made for securing a navigable channel in this bayou up to the dike at Plaquemine and for preventing further caving of the bank of the Mississippi at the "mouth" (head) of the bayou.

The deepening of the bayou by dredging and the construction of a system of locks to afford navigable entrance to the bayou from the Mississippi are in contemplation. The work of bank protection was placed in charge of this office by letter of May 15, 1889, from the Chief of Engineers, U. S. Army.

The plant belonging to the general works of improvement in the fourth district, Mississippi River, of which this office has also charge, was thus rendered available for the Plaquemine work at such time as it is not required elsewhere.

The sum $75,000 from the amount appropriated by the act of August 11, 1888, for the improvement of the bayou was allotted for bank protection at the head.

The approved project under which this sum was to be expended contemplated the building of four large submerged spur dikes with sloping crests running out at right angles to the shore. These dikes were to be built of willow brush, timber, and stone, in accordance with the general method of construction adopted by the Mississippi River Commission for that class of work in this part of the river, the shore end of each spur to extend up to low water, and from that point a spur levee, built of earth, was to run to the main levee. The portion of this levee below high-water line was to be covered with a layer of gravel and then a layer of stone. Four of the dikes were to be built with the funds available, two above the bayou and two below, at intervals of about 900 feet.

The two dikes above the bayou, Nos. 1 and 2, were built in 1889–'90.

The sum of $60,000 for continuing the work was allotted from the amount appropriated for the general improvement of the bayou by the act of September 19, 1890, but the lateness of the season when the appropriation became available rendered it impracticable to resume work before the following year.

During the fall and winter of 1891 needed repairs were made to Dike No. 1, and three dikes, Nos. 3, 4, and 5, were built.

The plan of the new dikes was modified, making the side slopes somewhat less steep than in those first constructed and omitting the spur levee extension at the head of the dike.

The protection work now extends to a distance of about 1,500 feet below the proposed entrance to the locks and 2,500 feet above.

There was left on hand at the date of the last annual report, 8,465 tons of rock, which is stored on the bank opposite Plaquemine. It was procured in accordance with my recommendation of February 11, 1892, that the balance of the funds on hand be expended in repairing and strengthening the bank-protection work.

During the past year no construction work has been done. On October 14, 1892, instructions were received from the Chief of Engineers to transfer the charge of this work and the property and funds to Maj. James B. Quinn, Corps of Engineers, U. S. Army.

The season's work under this office had been planned with a view to making repairs to the bank protection at Plaquemine as soon as the plant became available after completing similar work in the New Orleans Harbor. The necessity for repairs and strengthening the work had developed during the low-water season, and recommendation was therefore made on November 1, 1892, that the transfer be deferred until after the repairs could be made to the extent of the funds and material on hand. Notice of approval of this action was received on November 22, 1892. A quantity of willows for the work had been cut at Profit Island, but the season had become so far advanced and an early rise in the river having taken place, it was decided not to undertake the work until the following season. The willows were transferred and used on the New Orleans Harbor work. The plant has been put in order and will be available to resume this work as soon as the water goes down.

On June 19, 1893, a project was submitted for the expenditure of the funds and material on hand in repairs and strengthening the bank protection in the immediate vicinity of the proposed entrance to the locks. This project contemplates additional mattress work and rock paving above and below Dikes 3 and 4. The project was approved by the Chief of Engineers on June 23, 1893.

* * * * * * *

Very respectfully, your obedient servant,

JOHN MILLIS,
*Captain of Engineers.*

Brig. Gen. THOMAS L. CASEY,
*Chief of Engineers, U. S. A.*

NOTE.—The money statement for this work is consolidated with that for the improvement of Bayou Plaquemine, Louisiana, Appendix S 6.

# APPENDIX U.

## IMPROVEMENT OF CERTAIN RIVERS AND HARBORS IN TEXAS.

### *REPORT OF MAJ. A. M. MILLER, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1893, WITH OTHER DOCUMENTS RELATING TO THE WORKS.*

IMPROVEMENTS.

1. Entrance to Galveston Harbor, Texas.
2. Ship Channel in Galveston Bay, Texas.
3. Channel in West Galveston Bay, Texas.
4. Trinity River, Texas.
5. Cedar Bayou, Texas.
6. Buffalo Bayou, Texas.
7. Harbor at Brazos Santiago, Tex.

EXAMINATIONS.

8. Brazos River, Texas, from its mouth to Richmond.

UNITED STATES ENGINEER OFFICE,
*Galveston, Tex., July 8, 1893.*

GENERAL: I have the honor to transmit herewith the annual reports for the works under my charge for the fiscal year ending June 30, 1893.

Very respectfully, your obedient servant,

A. M. MILLER,
*Major, Corps of Engineers.*

Brig. Gen. THOMAS L. CASEY,
*Chief of Engineers, U. S. A.*

## U 1.

### IMPROVEMENT OF ENTRANCE TO GALVESTON HARBOR, TEXAS.

The project for this improvement was adopted in 1874 and modified in 1880, and again modified in 1886, the object being to deepen the channel so as to admit of sea-going vessels of the deepest draft entering the harbor.

The projects of 1874 and 1881 contemplated construction of two jetties to extend into the Gulf of Mexico to concentrate ebb flow upon the outer bar in the Gulf, and also to effect deepening on the inner bar at the entrance to Galveston Channel, these jetties to have their origins, respectively, at Bolivar Point and Fort Point.

More or less work was done under these projects. Under that of 1881 a jetty was built from Fort Point to the crest of the outer bar, but it was not fully completed.

The project of 1886 (that now in progress of execution) also consists in construction of jetties to extend into the Gulf, one, the south jetty, starting from the east end of Galveston Island, and the other, the north jetty, to start from Bolivar Point, opposite; or, to be more exact, the south jetty was to start from Fort Point, but in 1888 it was decided to connect the inner end of that jetty with the relatively high ground upon which the city of Galveston is built by a stone dike known as the shore branch.

The jetties are to be of rock, to be built to an elevation of 5 feet above mean low tide, and to extend, if necessary, to the contour of 30-foot depth in the Gulf, their sea ends to be 7,000 feet apart, the action of the jetties to be supplemented, if need be, by dredging, the south jetty to follow the line of the jetty of 1881.

The natural depth upon the outer bar was 12 feet and that upon the inner bar 13 feet at mean low tide. The general plan of the work is shown upon the accompanying map.

At the close of the fiscal year ending June 30, 1890, there had been constructed 19,200 linear feet of south jetty, of which 1,200 feet were incomplete. The railway trestle had been extended 428 feet beyond the rock work. The railway is used for transporting material to be deposited in the jetty. The contract under which the work for the fiscal year ending June 30, 1890, was done expired August 30, 1890, at which date there were 19,400 linear feet of jetty completed, 150 linear feet of incomplete jetty, and beyond that 318 linear feet of trestle and track. The shore branch is included in the foregoing.

Congress, by act approved September 19, 1890, made an appropriation for carrying on this work, and at the same time authorized a contract to be entered into for completing both jetties, payments to be made as appropriations were made from time to time.

Proposals for this work were invited in October, 1890 by public advertisement, but as the successful bidders failed to enter into the required contract it became necessary to readvertise the work. At the second letting the lowest bid, that of O'Connor, Laing & Smoot, of Dallas, Tex., was accepted and a contract was entered into with them for constructing the jetties on March 12, 1891. This contract was subsequently amended on February 10, 1892, allowing the use of sandstone weighing 10 pounds less per cubic yard, the price per ton being reduced 10 cents.

The contractors commenced construction on the south jetty on August 1, 1891, and by June 30, 1892, had accomplished the following:

| | Linear feet. |
|---|---|
| Completed jetty | 4,600 |
| Jetty built to average height of one-half foot above mean low tide | 2,200 |
| Jetty built to average height of 3 feet above foundation | 723 |
| Total of complete and incomplete jetty built during the fiscal year ending June 30, 1892 | 7,523 |

The total length of south jetty, constructed since work began upon it in 1887, is (shore branch included)—

| | Linear feet. |
|---|---|
| Completed jetty | 24,000 |
| Incomplete jetty | 2,923 |
| Total complete and incomplete June 30, 1892 | 26,923 |

The sea end of this work was then within 5,400 feet of the outer 12-foot contour or outer crest of the bar.

A survey made at the time showed a depth of 13¼ feet at mean low tide in the outer bar channel and a depth of 21 feet where the inner bar was.

The construction of the south jetty was continued during the fiscal year until May 30, 1893, when the crest of the outer bar, having been reached, the jetty was considered as complete for the present. The length added to south jetty during the fiscal year was 8,000 feet, in addition to which an apron 839 feet long was built from the outer end into the Gulf to protect it.

Construction on the north jetty was commenced in April, 1893, and at the close of the fiscal year 1,500 linear feet had been completed, in addition to which 2,100 linear feet was uncompleted.

The total length of the jetties constructed since work began in 1887 is:

| | Linear feet. |
|---|---|
| South jetty, completed | 32,000 |
| South jetty, uncompleted | 829 |
| North jetty, completed | 1,500 |
| North jetty, uncompleted | 2,100 |
| Total June 30, 1893 | 36,429 |

The usual annual survey of the bar and its channel, as well as of the harbor generally, was made in April, May, and June, 1893. The soundings show a channel depth of 14 feet at mean low tide in the outer bar, an increase of three-fourths of a foot, and a depth of 23 feet where the inner bar was, an increase of 2 feet since June 30, 1892. The bar channel between the 14-foot curves is from 350 to 700 feet wide. Galveston channel has deepened from 2 to 3 feet, with a maximum depth of 39½ feet. The principle changes in the position of contours since June 30, 1892, as developed by the survey and shown by the accompanying map, are as follows:

Inside the bar the contours from the 30-foot to the 12-foot have all advanced, while outside the bar in the Gulf the 30-foot has remained stationary, the 24-foot has receded, and the 18-foot and 12-foot have advanced.

The outer bar is slowly wearing away over a distance of about a mile north of South Jetty, where the 12-foot curve has receded.

Soundings shown on accompanying map are reduced to the plane of mean low tide, the plane to which previous soundings were reduced.

An account, in detail, of the season's operations is shown in the accompanying report of Mr. E. M. Hartrick, assistant engineer, to which attention is called.

Proposals were invited May 1, 1893, for the construction of a twin-screw propellor, for use in connection with this work. The lowest bid received at the opening, June 12, 1893, was that of T. S. Marvel & Co., of Newburg, N. Y., which was accepted and contracts were sent them for signature, but they had not been signed at the close of the fiscal year.

| | |
|---|---|
| Amount expended under all projects to June 30, 1892 | $2,712,843.53 |
| Amount expended during fiscal year ending June 30, 1893 | 646,796.29 |
| Total amount expended to June 30, 1893 | 3,359,639.82 |
| Original estimated cost of the work in 1886 | 8,478,000.00 |
| Aggregate amount appropriated to June 30, 1893 | 4,828,000.00 |

In addition to this there was expended the sum of $100,000 subscribed by the city of Galveston in 1883.

The work is located in the collection district of Galveston. The nearest houses are at Bolivar Point and Fort Point at the entrance to Galveston Bay. amount of revenue collected at the port of Galveston for fiscal year endin 30, 1893, was $132,696.66.

*Abstract of appropriations made by Congress for improving harbor at Galveston,*

| | |
|---|---|
| By act approved— | |
| July 11, 1870 | $2 |
| March 3, 1871 | 2 |
| June 10, 1872 | 3 |
| June 23, 1874 | 6 |
| March 3, 1875 | 15 |
| August 14, 1876 | 14 |
| June 7, 1878 | 7 |
| June 18, 1878 | 5 |
| March 3, 1879 | 10 |
| June 14, 1880 | 17 |
| March 3, 1881 | 250 |
| March 4, 1882 | 100 |
| By act passed August 2, 1882 | 300, |
| By act approved August 5, 1886 | 300, |
| By act of August 11, 1888 | 500, |
| By act approved— | |
| September 19, 1890 | 500, 0 |
| March 3, 1891 | 600, 0 |
| August 5, 1892 | 450, 0 |
| March 3, 1893 | 1, 000, 0 |
| Total | 4, 828, 0 |

## *Money statement.*

| | | |
|---|---|---|
| July 1, 1892, balance unexpended | | $665, 156. 4 |
| July 14, 1892, repayment of amount of compromise in suit *vs.* J. H. Mooney *et al* | | 118. 0 |
| Amount appropriated by sundry civil act approved August 5, 1892 | | 450, 000. 0 |
| Amount appropriated by sundry civil act approved March 3, 1893 | | 1, 000, 000. 0 |
| | | 2, 115, 274. 47 |
| June 30, 1893, amount expended during fiscal year | | 646, 796. 29 |
| July 1, 1893, balance unexpended | | 1, 468. 478. 18 |
| July 1, 1893, outstanding liabilities | $32, 138. 97 | |
| July 1, 1893, amount covered by uncompleted contracts | 1, 328, 104. 33 | |
| | | 1, 360, 243. 30 |
| July 1, 1893, balance available | | 108, 234. 88 |
| Amount (estimated) required for completion of existing project | | 3, 650, 000. 00 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895 | | 1,000, 000. 00 |
| Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893. | | |

*Abstract of proposals for constructing a steel twin-screw steam propeller received in response to advertisement dated May 1, 1893, and opened June 12, 1893, at Galveston, Tex., by Maj. A. M. Miller, Corps of Engineers.*

| No. | Name and address of bidders. | Price. | Time of delivery. | Remarks. |
|---|---|---|---|---|
| 1 | C. Reeder & Sons, Baltimore, Md | $33, 985 | Dec. 28, 1893 | |
| 2 | Ed. J. Howard, Jeffersonville, Ind | 36, 000 | 7 months from date of contract. | No seals attached. |
| 3 | T. S. Marvel & Co., Newburg, N. Y | 28, 500 | Jan. 15, 1894 | |
| 4 | John H. Dialogue & Son, Camden, N. J | 30, 600 | No date given | No guarantee to proposals. |
| 5 | The M. A. Sweeny Co., Jeffersonville, Ind | 34, 480 | Dec. 31, 1893 | |

No. 3 lowest bid; acceptance recommended.

## ON HARBOR, TEXAS

MADE UNDER THE DIRECTION OF

ER CORPS OF ENG'RS. U. S. A.

BY

ARTRICK, ASS'T. ENG'R.

&

IKOFER, ASS'T ENG'R.

N MAY & JUNE 1893

Scale $\frac{1}{50,000}$

Eng 93

## REPORT OF MR. E. M. HARTRICK, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
*Galveston, Tex., June 30, 1893.*

MAJOR: I have the honor to submit the following report of operations for improving Galveston Harbor, Texas, during the fiscal year ending June 30, 1893.

*Condition of work at beginning of fiscal year.*—The jetty was completed and properly protected with granite blocks to Station 240. The trestle and riprap apron was at Station 269+23. The riprap mound, over which the contractors could work, extended from Station 240 to 262, a distance of 2,200 feet, but, on account of inadequate mechanical appliances the outer protection of granite blocks progressed in a very slow and tedious manner; the castings, booms, blocks, and hooks of the four derricks on the two barges constantly breaking, owing to the surge of sea and rope.

*Casualties.*—There was no storm of any severity during the year. Gales from the northeast and southeast followed by a storm from the northwest totally suspended work on the 17th and 18th of January, 1893. On taking soundings and inspecting the work, as soon as the weather moderated, it was found that a settlement of about 2¼ feet had occurred over the riprap apron, with a scour of about 6 feet in advance of said apron. The last three bents of the trestle settled one-half a foot under the weight of the pile-driver, when sent to the front after the storm.

The apron, in this particular location, is placed on the sandy bottom of the Gulf with no brush-mattress foundation.

No damage was observed over the completed jetty. On the incomplete work a few 6 and 8 ton granite blocks were displaced that had not been properly placed and about four cars of sandstone riprap washed down from the crest onto the slope.

*Inspection, construction, and transfer.*—The general method of construction and inspection was the same as explained in last Annual Report of Chief of Engineers, for 1892. (Appendix U, p. 1529.)

On north jetty, owing to the contractors' tardiness in providing a site in their yard at Bolivar for the Government railway track scales, the stone is weighed and inspected at Fort Point Yards.

The cars, after being inspected and weighed are run to a wharf, where a movable apron is situated, that can be adjusted to the rise and fall of tides.

An ordinary freight barge, that has been adapted for transferring railway cars, had been previously put in place with the apron resting on the barge. The barge and apron, with their floating and movable track practically abutting and coinciding, are held in place by a system of lines, capstans, and fender piles.

The cars are then pushed by the locomotive over the apron onto the barge. The tug then takes the barge in tow and transfers the load to the contractor's similarly arranged wharf at Bolivar, where another locomotive takes it to the storage yard. Then, as the necessities of the work demand, the stock in the storage yard is drawn on, trains made up, and sent to the front as on south jetty.

The contractors have also transferred stone in bulk, as follows: Cars are inspected and weighed, as above, at Fort Point, and run out on south jetty abreast of north jetty and unloaded on a barge, which is towed to north jetty and unloaded on the work. This system gives from 1 to 2 per cent of lost material (contractors' loss) and requires extra inspection on the part of the Government to prevent waste when unloading from barge, as the riprap apron and mound is apt to take a wider base and flatter slope than is neccessary.

*North jetty.*—In October, 1892, the contractors were notified and the place of beginning pointed out for the shore end of north jetty at Bolivar.

They had been warned previously from time to time that they might expect such an order and to make preparations accordingly, but it was not until April, 1893, six months after, that the first stone was placed in the jetty.

The Government in June, 1893, commenced and completed the railway track scales and office at Bolivar for weighing and inspection of material for north jetty, and it is the intention to have the headquarters in the field transferred from Fort Point to Bolivar after the 4th of July, 1893.

*General progress and advance of work during the year.*—The work has been more or less retarded by a general lack of material, unsuitable plant, boisterous weather, and rough seas.

The south jetty advanced 8,000 feet, from station 240 to 320, with a riprap apron, trestle, and track extending 839 feet further into the Gulf to Station 328+39.

The north jetty is complete from station 0 to 15, an advance of 1,500 feet, with an incomplete portion, including apron of 2,100 feet, to Station 36. The track and trestle are at station 38.

TABLE NO. 1.—*Showing the kind and amount of stone used in south jetty.*

| Month. | Cars. | Riprap. | Cars. | Block. | To ca |
|---|---|---|---|---|---|
| 1892. | | *Tons.* | | *Tons.* | |
| July | 539 | 9,618.65 | 312 | 5,860.75 | |
| August | 898 | 16,558.78 | 390 | 8,564.92 | 1 |
| September | 697 | 14,451.99 | 365 | 8,741.89 | 1 |
| October | 403 | 8,775.00 | 317 | 7,793.34 | |
| November | 506 | 11,134.04 | 331 | 8,356.42 | |
| December | 254 | 5,533.27 | 348 | 8,476.21 | |
| 1893. | | | | | |
| January | 398 | 8,053.67 | 319 | 7,191.81 | |
| February | 620 | 12,704.70 | 244 | 5,682.23 | |
| March | 709 | 15,101.44 | 184 | 4,365.91 | |
| April | 46 | 949.42 | 210 | 4,761.03 | |
| May | 21 | 406.88 | 113 | 2,586.27 | |
| June | 8 | 156.04 | ........ | ........ | |
| Total | 5,099 | 103,443.88 | 3,133 | 72,380.78 | 8 |

TABLE NO. 2.—*Showing quantities of stone used and cost of same in south jetty,*
*other items of expense, not including office and inspection expenses.*

From Station 0 to 79+64 (7,964 feet).

| Items. | Tons. | Cost. | Tons per foot. | Cos per f |
|---|---|---|---|---|
| Riprap | ........ | ........ | ........ | ........ |
| Block | ........ | ........ | ........ | ........ |
| Railway | ........ | ........ | ........ | ........ |
| Extras | ........ | $52.34 | ........ | $ |
| Total for year | ........ | 52.34 | ........ | |
| Previous expenditures | 3,067.30<br>*44,259.96 | ........<br>152,657.79 | .39<br>*5.55 | ........<br>1 |
| Grand total | ........ | 152,710.13 | ........ | 1 |

From Station 79+64 to 84+64 (500 feet).

| Items. | Tons. | Cost. | Tons per foot. | Cos per f |
|---|---|---|---|---|
| Riprap | ........ | ........ | ........ | ........ |
| Block | ........ | ........ | ........ | ........ |
| Railway | ........ | ........ | ........ | ........ |
| Extras | ........ | $4.19 | ........ | $ |
| Total for year | ........ | 4.19 | ........ | |
| Previous expenditures | *5,998.81 | 16,235.08 | *12.00 | 32 |
| Grand total | ........ | 16,239.27 | ........ | 32 |

From Station 84+64 to 95+64 (1,100 feet).

| Items. | Tons. | Cost. | Tons per foot. | Cos per f |
|---|---|---|---|---|
| Riprap | ........ | ........ | ........ | ........ |
| Block | ........ | ........ | ........ | ........ |
| Railway | ........ | ........ | ........ | ........ |
| Extras | ........ | $9.23 | ........ | $0 |
| Total for year | ........ | 9.23 | ........ | |
| Previous expenditures | *9,594.51 | 29,027.07 | *8.72 | 26 |
| Grand total | ........ | 29,036.30 | ........ | 26 |

From Station 95+64 to 107+64 (1,200 feet).

| Items. | Tons. | Cost. | Tons per foot. | Cos per f |
|---|---|---|---|---|
| Riprap | ........ | ........ | ........ | ........ |
| Block | ........ | ........ | ........ | ........ |
| Railway | ........ | ........ | ........ | ........ |
| Extras | ........ | $10.08 | ........ | $0. |
| Total for year | ........ | 10.08 | ........ | |
| Previous expenditures | *13,094.47 | 41,238.72 | *10.92 | 34. |
| Grand total | ........ | 41,248.80 | ........ | 34. |

* Cubic yards.

TABLE No. 2.—*Showing quantities of stone used and cost of same in south jetty, and other items of expense, etc.*—Continued.

From Station 107+64 to 138+64 (3,100 feet).

| Items. | Tons. | Cost. | Tons per foot. | Cost per foot. |
|---|---|---|---|---|
| Riprap | | | | |
| Block | | | | |
| Railway | | | | |
| Extras | | $26.03 | | $0.01 |
| Total for year | | 26.03 | | .01 |
| Previous expenditures | *72,180.09 | 216,268.53 | *23.28 | 69.76 |
| Grand total | | 216,294.56 | | 69.77 |

From Station 138+64 to 144+12 (548 feet).

| Items. | Tons. | Cost. | Tons per foot. | Cost per foot. |
|---|---|---|---|---|
| Riprap | | | | |
| Block | | | | |
| Railway | | | | |
| Extras | | $4.76 | | $0.01 |
| Total for year | | 4.76 | | .01 |
| Previous expenditures | *12,567.62 | 39,120.73 | *22.93 | 71.38 |
| Grand total | | 39,125.49 | | 71.39 |

From Station 144+12 to 150 (588 feet).

| Items. | Tons. | Cost. | Tons per foot. | Cost per foot. |
|---|---|---|---|---|
| Riprap | | | | |
| Block | | | | |
| Railway | | | | |
| Extras | | $4.97 | | $0.01 |
| Total for year | | 4.97 | | .01 |
| Previous expenditures | *12,740.68 | 34,335.34 | *21.67 | 58.39 |
| Grand total | | 34,340.31 | | 58.40 |

From Station 150 to 160 (1,000 feet).

| Items. | Tons. | Cost. | Tons per foot. | Cost per foot. |
|---|---|---|---|---|
| Riprap | | | | |
| Block | | | | |
| Railway | | | | |
| Extras | | $8.40 | | $0.01 |
| Total for year | | 8.40 | | .01 |
| Previous expenditures | *19,623.31 | 54.632.14 | *19.62 | 54.63 |
| Grand total | | 54,640.54 | | 54.64 |

From Station 160 to 170 (1,000 feet).

| Items. | Tons. | Cost. | Tons per foot. | Cost per foot. |
|---|---|---|---|---|
| Riprap | | | | |
| Block | | | | |
| Railway | | | | |
| Extras | | $8.40 | | $0.01 |
| Total for year | | 8.40 | | .01 |
| Previous expenditures | *19,679.77 | 53,816.05 | *19.68 | 53.81 |
| Grand total | | 53,824.45 | | 53.82 |

From Station 170 to 180 (1,000 feet).

| Items. | Tons. | Cost. | Tons per foot. | Cost per foot. |
|---|---|---|---|---|
| Riprap | | | | |
| Block | | | | |
| Railway | | | | |
| Extras | | $8.40 | | $0.01 |
| Total for year | | 8.40 | | .01 |
| Previous expenditures | *13,285.98 | 38,669.39 | *13.28 | 38.67 |
| Grand total | | 38,677.79 | | 38.68 |

*Cubic yards.

TABLE No. 2.—*Showing quantities of stone used and cost of same in south jetty, other items of expense, etc.*—Continued.

From Station 180 to 190 (1,000 feet).

| Items. | Tons. | Cost. | Tons per foot. | C per |
|---|---|---|---|---|
| Riprap | .......... | .......... | .......... | .... |
| Block | .......... | .......... | .......... | .... |
| Railway | .......... | .......... | .......... | .... |
| Extras | .......... | $8.40 | .......... | |
| Total for year | .......... | 8.40 | .......... | |
| Previous expenditures | 387.70<br>*14,490.87 | 41,917.53 | 0.39<br>* 14.49 | .... |
| Grand total | .......... | 41,925.93 | .......... | |

From Station 190 to 200 (1,000 feet).

| Items. | Tons. | Cost. | Tons per foot. | C per |
|---|---|---|---|---|
| Riprap | .......... | .......... | .......... | .... |
| Block | .......... | .......... | .......... | .... |
| Railway | .......... | .......... | .......... | .... |
| Extras | .......... | $8.24 | .......... | |
| Total for year | .......... | 8.24 | .......... | |
| Previous expenditures | 16,796.21<br>*8,531.53 | 77,870.54 | 16.80<br>*21.02 | .... |
| Grand total | .......... | 77,878.78 | .......... | |

From Station 200 to 210 (1,000 feet).

| Items. | Tons. | Cost. | Tons per foot. | C per |
|---|---|---|---|---|
| Riprap | .......... | .......... | .......... | .... |
| Block | .......... | .......... | .......... | .... |
| Railway | .......... | .......... | .......... | .... |
| Extras | .......... | $8.40 | .......... | |
| Total for year | .......... | 8.40 | .......... | |
| Previous expenditures | 24,216.15 | 79,271.96 | 24.22 | |
| Grand total | 24,216.15 | 79,280.36 | 24.22 | |

From Station 210 to 220 (1,000 feet).

| Items. | Tons. | Cost. | Tons per foot. | C per |
|---|---|---|---|---|
| Riprap | .......... | .......... | .......... | .... |
| Block | .......... | .......... | .......... | .... |
| Railway | .......... | .......... | .......... | .... |
| Extras | .......... | $8.40 | .......... | |
| Total for year | .......... | 8.40 | .......... | |
| Previous expenditures | 22,276.87 | 74,030.48 | 22.27 | |
| Grand total | 22,276.87 | 74,038.88 | 22.27 | |

From Station 220 to 230 (1,000 feet).

| Items. | Tons. | Cost. | Tons per foot. | C per |
|---|---|---|---|---|
| Riprap | .......... | .......... | .......... | .... |
| Block | .......... | .......... | .......... | .... |
| Railway | .......... | .......... | .......... | .... |
| Extras | .......... | $8.40 | .......... | |
| Total for year | .......... | 8.40 | .......... | |
| Previous expenditures | 20,992.06 | 70,616.42 | 20.99 | |
| Grand total | 20,992.06 | 70,624.82 | 20.99 | |

From Station 230 to 240 (1,000 feet).

| Items. | Tons. | Cost. | Tons per foot. | C per |
|---|---|---|---|---|
| Riprap | 338.96 | $796.56 | .34 | |
| Block | .......... | .......... | .......... | .... |
| Railway | .......... | .......... | .......... | .... |
| Extras | .......... | 8.40 | .......... | |
| Total for year | 338.96 | 804.96 | .34 | |
| Previous expenditures | 22,718.09 | 73,935.14 | 22.71 | |
| Grand total | 23,057.05 | 74,740.10 | 23.05 | |

* Cubic yards.

TABLE No. 2.—*Showing quantities of stone used and cost of same in south jetty, and other items of expense, etc.*—Continued.

From Station 240 to 250 (1,000 feet).

| Items. | Tons. | Cost. | Tons per foot. | Cost per foot. |
|---|---|---|---|---|
| Riprap | 2,996.27 | $7,041.22 | 3.00 | $7.04 |
| Block | 4,834.46 | 20,546.46 | 4.83 | 20.54 |
| Railway | | | | |
| Extras | | 21.90 | | .03 |
| Total for year | 7,830.73 | 27,609.58 | 7.83 | 27.61 |
| Previous expenditures | 16,113.78 | 50,936.70 | 16.11 | 50.93 |
| Grand total | 23,944.51 | 78,546.28 | 23.94 | 78.54 |

From Station 250 to 260 (1,000 feet).

| | | | | |
|---|---|---|---|---|
| Riprap | 3,187.60 | $7,490.86 | 3.19 | $7.49 |
| Block | 4,641.72 | 19,727.32 | 4.64 | 19.73 |
| Railway | | | | |
| Extras | | 46.16 | | 0.04 |
| Total for year | 7,829.32 | 27,264.34 | 7.83 | 27.26 |
| Previous expenditures | 17,030.97 | 53,592.34 | 17.03 | 53.59 |
| Grand total | 24,860.29 | 80,856.68 | 24.86 | 80.85 |

From Station 260 to 270 (1,000 feet).

| | | | | |
|---|---|---|---|---|
| Riprap | 11,181.40 | $26,276.30 | 11.18 | $26.28 |
| Block | 9,514.26 | 40,435.61 | 9.51 | 40.43 |
| Railway | | 614.00 | | 0.61 |
| Extras | | 52.07 | | 0.05 |
| Total for year | 20,695.66 | 67,377.98 | 20.69 | 67.37 |
| Previous expenditures | 6,420.61 | 20,400.45 | 6.42 | 20.40 |
| Grand total | 27,116.27 | 87,778.43 | 27.11 | 87.77 |

From Station 270 to 280 (1,000 feet).

| | | | | |
|---|---|---|---|---|
| Riprap | 13,444.61 | $31,594.84 | 13.44 | $31.60 |
| Block | 9,859.44 | 41,902.62 | 9.86 | 41.90 |
| Railway | | 4,373.39 | | 4.37 |
| Extras | | 93.82 | | 0.09 |
| Total for year | 23,304.05 | 77,964.67 | 23.30 | 77.96 |

From Station 280 to 290 (1,000 feet).

| | | | | |
|---|---|---|---|---|
| Riprap | 12,548.17 | $29,488.20 | 12.55 | $29.49 |
| Block | 9,003.14 | 38,263.35 | 9.00 | 38.26 |
| Railway | | 4,340.00 | | 4.34 |
| Extras | | 97.07 | | .10 |
| Total for year | 21,551.31 | 72,188.62 | 21.55 | 72.19 |

From Station 290 to 300 (1,000 feet).

| | | | | |
|---|---|---|---|---|
| Riprap | 12,635.36 | $29,693.09 | 12.64 | $29.69 |
| Block | 9,951.74 | 42,294.90 | 9.95 | 42.29 |
| Railway | | 4,354.00 | | 4.35 |
| Extras | | 105.83 | | .11 |
| Total for year | 22,587.10 | 76,447.82 | 22.59 | 76.44 |

TABLE NO. 2.—*Showing quantities of stone used and cost of same in south jetty, other items of expense, etc.*—Continued.

From Station 300 to 310 (1,000 feet).

| Items. | Tons. | Cost. | Tons per foot. | Co per f |
|---|---|---|---|---|
| Riprap | 13,568.54 | $31,886.05 | 13.57 | $3 |
| Block | 9,547.44 | 40,576.62 | 9.54 | 4 |
| Railway | .......... | 4,208.64 | .......... | |
| Extras | .......... | 84.17 | .......... | |
| Total for year | 23,115.98 | 76,755.48 | 23.11 | 7 |

From Station 310 to 320 (1,000 feet).

| Items. | Tons. | Cost. | Tons per foot. | Co per f |
|---|---|---|---|---|
| Riprap | 26,191.29 | $61,549.54 | 26.19 | $6 |
| Block | 14,353.70 | 62,177.62 | 14.35 | 6 |
| Railway | .......... | 4,239.60 | .......... | |
| Extras | .......... | 64.60 | .......... | |
| Total for year | 40,544.99 | 128,031.36 | 40.54 | 12 |

From Station 320* to 328+39 (839 feet apron).

| Items. | Tons. | Cost. | Tons per foot. | Co per f |
|---|---|---|---|---|
| Riprap | 7,351.68 | $17,276.44 | 8.76 | $2 |
| Block | 45.42 | 199.85 | .05 | |
| Railway | .......... | 3,409.41 | .......... | |
| Extras | .......... | 30.62 | .......... | |
| Total for year | 7,397.10 | 20,916.32 | 8.81 | 2 |

* Unfinished; only an apron of about 5 feet thick and 30 feet wide.

TABLE NO. 3.—*Synopsis showing average cost per foot between the following station South Jetty.*

[Cost per foot includes railway and extras. Not including office and inspection expenses.]

| Stations. | Average depth. | Distance. | This year (per foot). | To date (per foot). | Remarks. |
|---|---|---|---|---|---|
| | *Feet.* | *Feet.* | | | |
| 0 to 79+64 | 1.07 | 7,964 | $0.01 | $19.18 | Shore connect across old ch nel. |
| 79+64 to 84+64 | — 3.00 | 500 | .01 | 82.47 | |
| 84+64 to 95+64 | — 2.45 | 1,160 | .01 | 26.40 | |
| 95+64 to 107+64 | — 1.5 | 1,200 | .01 | 34.87 | Clay core. |
| 107+64 to 138+64 | — 5.7 | 3,100 | .01 | 69.77 | Do. |
| 138+64 to 144+12 | — 9.5 | 548 | .01 | 71.39 | Do. |
| 144+12 to 150 | — 7.50 | 588 | .01 | 58.40 | |
| 150 to 160 | — 7.30 | 1,000 | .01 | 54.64 | |
| 160 to 170 | — 8.65 | 1,000 | .01 | 53.82 | |
| 170 to 180 | — 7.00 | 1,000 | .01 | 38.68 | |
| 180 to 190 | — 7.50 | 1,000 | .01 | 41.93 | |
| 190 to 200 | —10.95 | 1,000 | .01 | 77.88 | Granite pro tion from S tion 194, |
| 200 to 210 | —10.35 | 1,000 | .01 | 79.28 | |
| 210 to 220 | — 9.60 | 1,000 | .01 | 74.04 | |
| 220 to 230 | — 7.00 | 1,000 | .01 | 70.62 | |
| 230 to 240 | — 8.70 | 1,000 | .81 | 74.74 | |
| 240 to 250 | — 9.00 | 1,000 | 27.61 | 78.54 | |
| 250 to 260 | — 9.30 | 1,000 | 27.26 | 80.85 | |
| 260 to 270 | —10.20 | 1,000 | 67.37 | 87.77 | |
| 270 to 280 | — 9.10 | 1,000 | 77.95 | 77.96 | |
| 280 to 290 | — 9.20 | 1,000 | 72.19 | 72.19 | |
| 290 to 300 | — 9.10 | 1,000 | 76.44 | 76.44 | |
| 300 to 310 | —10.10 | 1,000 | 76.75 | 76.75 | End of mattres |
| 310 to 320 | —16.50 | 1,000 | 128.03 | 128.03 | Sand foundati |
| 320* to 328+39 | —15.10 | 839 | 24.93 | 24.93 | (839 ft. of apron) |

* Apron about 5 feet thick and 35 feet wide; all riprap, no granite.

TABLE No. 4.—*Showing the kind and amount of stone used in the North Jetty.*

| | Cars. | Riprap. | Cars. | Block. | Total cars. |
|---|---|---|---|---|---|
| | | *Tons.* | | *Tons.* | |
| April, 1893 | 29 | 558.31 | 14 | 256.45 | 43 |
| May, 1893 | 496 | 10,033.13 | 85 | 1,710.10 | 581 |
| June, 1893 | 620 | 13,002.18 | 153 | 3,377.00 | 773 |
| Total | 1,145 | 23,503.62 | 252 | 5,343.55 | 1,397 |

*Annual survey and comparative cross sections and profile.*—The annual survey was commenced in April and continued through May and June, 1893. Cross sections and profile were taken over the entire length of South Jetty, from Station O, at Ninth street, Galveston, to Station 328 + 39, in the Gulf of Mexico. The profile is taken every 7½ feet and the cross sections every 100 feet, extending 100 feet from axis on each side of jetty.

By comparing with former years it will be observed that there is a decided sand accretion along both sides of South Jetty, in some places, as at Station 110, appearing at the surface and forming a beach at low water on the south side. This accretion has made the jetty practically water-tight at low water as far as Station 110, at lower low water as far out as Station 162, and at extreme low water to Station 185.

The 30-foot, 24-foot, 18-foot and 12-foot curves of depth inside the bar have advanced.

Outside the bar, in the Gulf, the 30-foot has remained stationary, the 24-foot has receded, and the 18-foot and 12-foot advanced. The outer bar is slowly wearing away over a distance of about a mile north of South Jetty, where the 12-foot curve has receded.

The bar channel between the 14-foot curves is from 350 to 700 feet wide.

There is 14½ feet, but not navigable on account of the tortuous channel. This is an increase in depth over last year of 1 foot.

The inner bar has a navigable channel depth of a good 23 feet, an increase of 2 feet in twelve months.

Galveston channel has deepened from 2 to 3 feet off the Red and Black Beacons, with a maximum depth of 39½ feet.

The shoals south of Light Ship and Bird Island Shoal remain about the same.

The shore line on Bolivar has not changed, except in the immediate vicinity of North Jetty. On Galveston Island the erosion along the beach south of first street still continues, and the accretion north of first street is becoming higher, with a slight advance, toward the Gulf.

E. M. HARTRICK,
*Assistant Engineer.*

Maj. A. M. MILLER,
*Corps of Engineers, U. S. A.*

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## COMMERCIAL STATISTICS OF GALVESTON HARBOR, TEXAS, FOR FISCAL YEAR ENDING JUNE 30, 1893.

### *Tonnage of vessels and revenue collected.*

[From statement furnished by N. W. Cuney, esq., collector of the port.]

| | |
|---|---|
| Steam vessels entered | 300 |
| Sailing vessels entered | 114 |
| Total | 414 |
| Steam vessels cleared | 295 |
| Sailing vessels cleared | 36 |
| Total | 331 |
| Total tonnage of vessels entered | 497,150 |
| Total tonnage of vessels cleared | 489,563 |
| Total tonnage | 986,713 |
| Amount of revenue collected | $132,696.66 |

*Amount and value of freight shipped.*

[From statement furnished by Mr. Julius Runge, president Galveston Cotton Exchange.]

| Articles. | Tons. | Approximate value. | Approx mate frei charge |
|---|---|---|---|
| Cotton, (1,044,677 bales) | 242,515 | $46,480,000 | $3,01 |
| Cotton seed, cake, and oil | 82,808 | 1,758,000 | 45 |
| Corn and wheat | 36,330 | 914,000 | 14 |
| Ore | 1,418 | 128,000 | |
| Wool | 3,832 | 1,302,000 | 5 |
| General merchandise | 3,845 | 668,000 | 3 |
| Total | 370,248 | 51,250,000 | 3,70 |

Decrease of freight carried over last year, 23,163 tons.
Decrease of tonnage of vessels over last year, 147,613 tons.

*Comparative statement of commercial statistics of the port of Galveston, Tex., for the f years ending June 30, 1887, 1888, 1889, 1890, 1891, 1892, and 1893.*

| Years. | Vessels entered. | | Vessels cleared. | | Tonnage. | | Total. | Cotton shipped. | Other merchandise. | Rev c lec |
|---|---|---|---|---|---|---|---|---|---|---|
| | Steam. | Sailing. | Steam. | Sailing. | Entered. | Cleared. | | | | |
| | | | | | | | | *Tons.* | *Tons.* | |
| 1887 | 250 | 296 | 256 | 238 | 446,711 | 444,801 | 891,512 | ........ | ........ | $17 |
| 1888 | 250 | 231 | 249 | 193 | 447,144 | 432,588 | 879,732 | ........ | ........ | 23 |
| 1889 | 250 | 131 | 244 | 124 | 416,468 | 403,896 | 820,364 | ........ | ........ | 15 |
| 1890 | 302 | 145 | 304 | 115 | 501,695 | 492,677 | 999,372 | 223,486 | 86,023 | 13 |
| 1891 | 242 | 139 | 345 | 96 | 544,862 | 529,058 | 1,073,920 | 258,638 | 71,980 | 17 |
| 1892 | 345 | 137 | 342 | 62 | 587,216 | 547,110 | 1,134,326 | 287,377 | 106,034 | 16 |
| 1893 | 300 | 114 | 295 | 36 | 497,150 | 489,563 | 986,713 | 242,515 | 127,733 | 13 |

## U 2.

## IMPROVEMENT OF SHIP CHANNEL IN GALVESTON BAY, TEXAS.

A project for this improvement was adopted in 1871 and modifie 1877; a subsequent modification, however, became necessary in 1 owing to the acquisition by the United States of the Morgan Cut Canal, formerly owned by the Buffalo Bayou Ship-Channel Compa together with its charter and rights under it. The cut and ca extends from the end of the ship channel in Galveston Bay, thro Morgan Point to the San Jacinto River, a distance of 5.4 miles, an now considered part of the ship channel proper.

The project as modified in 1892 consists in excavating a channel least 100 feet wide and 12 feet deep, from Bolivar Channel through veston Bay and the Morgan Cut and Canal to the San Jacinto Ri a distance of 24.33 miles, the ruling depth from Bolivar Channe Morgan Beacon (18.9 miles) being 8½ feet, that from Morgan Bea to Morgan Canal (4.8 miles) being 7½ feet, and the depth through canal (0.63 mile) being 17 feet.

This work is one link in a waterway connecting Houston with Gulf of Mexico, the other links being the San Jacinto River and Bu Bayou.

The estimated cost of the ship-channel improvement, as revise 1892, was $896,175.44, in connection with which it was stated tha would require an annual appropriation of $100,000 to maintain channel after it was completed. Dredging was carried on u appropriations made from 1875 to 1888, and a channel of the des width and depth had been excavated from Bolivar Channel to the Morgan Cut by July, 1889, but as no work was carried on from then until the end of the last fiscal year the channel shoaled very considerably.

An appropriation of $40,000 was made for this work by act of September 19, 1890, but as Morgan Cut and Canal were included in the work nothing could be done until they were acquired by the United States. As this did not take place until May 4, 1892, nothing was done under this appropriation up to the close of the last fiscal year. The river and harbor act of July 13, 1892, also appropriated $40,000 for this work and the project prepared for its expenditure included the amount appropriated by the former act, thus making a total of $80,000 available for the work. The project, as approved, consisted in dredging a channel at Red Fish Bar and in Morgan Cut, having a depth of 9½ feet below mean low tide and a width at bottom of about 100 feet, in revetting about 1,900 linear feet of the west bank of Morgan Canal, and in sloping both banks of the canal to prevent erosion.

Proposals were invited for doing this work, by advertisement dated September 5, 1892, bids to be opened October 5, 1892. But one bid was received at the opening, that of the Rittenhouse Moore Dredging Company, of Mobile, Ala., and it was recommended that it be rejected as being too high in the aggregate, that the readvertisement for dredging be postponed for the present, and that the revetment and sloping of banks at the canal be done by hired labor and purchase of material in open market.

This recommendation having been approved, arrangements were made to employ a grading outfit for sloping banks at Morgan Canal, also for the construction of the revetment by hired labor.

This latter work was commenced January 5, 1893, and was completed April 7, 1893, during which time 12,550 cubic yards of material was moved at a cost of 12½ cents per cubic yard including inspection. The revetment of the west bank of the canal was commenced February 22, 1893, and completed May 30, 1893; its length was 1,959 feet and cost $5.33 per linear foot, including inspection.

The details of this work are shown in the report of Mr. Donald Allen, Assistant Engineer, which is forwarded herewith. Dredging was re-advertised January 28, 1893, the bids being opened February 28, 1893, on which date four were received, the lowest bid, that of the Rittenhouse Moore Dredging Company, of Mobile, Ala., being accepted and a contract was entered into with them for this work on March 21, 1893. Owing to an accident happening to the contractors' plant while en route to Galveston and to delays in making repairs no dredging was done up to the end of the fiscal year; work will, however, be commenced at an early date an prosecuted diligently. Under the terms of the contract the dredging is be completed by October 25, 1893.

It is not practicable to give exact statistics of the commerce through the ship channel. Almost the entire floating commerce of Buffalo Bayou, of San Jacinto River, of Trinity River, and of Cedar Bayou is carried through this channel. Commercial statistics of those streams are given in the annual reports of pertaining improvements.

It is believed by many of the best informed men of Houston that the advantages to be derived from enabling seagoing ships to reach Houston by way of the ship channel and Buffalo Bayou will be vastly greater than the cost of making and maintaining the channel. The annual report of Buffalo Bayou gives as full statistics of the freight carried upon that stream as could be obtained. It is carried in barges drawing 5 feet when fully loaded and towed by tugs drawing 7 feet and less. These cross Galveston Bay, but the depth of water is already sufficient for them. A large proportion of this freight would be loaded directly upon seagoing vessels if they visited Houston. One item of shipment by water down Buffalo Bayou from Houston during the past fiscal year was 279,316 bales of cotton.

| | |
|---|---|
| Total expended on this improvement to June 30, 1892 | $540,831.16 |
| Total expended during fiscal year ending June 30, 1893 | 16,484.64 |
| Original estimated cost of this work as revised in 1892 | 896,175.44 |
| Aggregate amount appropriated to July 1, 1893 | 626,500.00 |
| Amount expended to July 1, 1893 | 557,315.80 |
| The amount required for maintenance after the completion of the original excavation (annually) | 100,000.00 |

The work is located in the collection district of Galveston. The light-houses on or near the line of the work are at Bolivar Point, Fort Point, Half-Moon Shoal, and Red Fish Bar. The amount of revenue collected at the port of Galveston during the fiscal year ending June 30, 1893, was $132,696.66.

*Abstract of appropriations made by Congress for improving ship channel in Galveston Bay, Texas.*

| | |
|---|---|
| By act approved— | |
| March 3, 1875 | $25,000 |
| August 4, 1876 | 72,000 |
| June 18, 1878 | 75,000 |
| March 3, 1879 | 80,000 |
| June 14, 1880 | 50,000 |
| March 3, 1881 | 50,000 |
| By act passed August 2, 1882 | 94,500 |
| By act of August 11, 1888 | 100,000 |
| By act of September 19, 1890 | 40,000 |
| By act of July 13, 1892 | 40,000 |
| Total | 626,500 |

The amount that can be profitably expended during the fiscal year ending June 30, 1895, is $200,000, to be applied to dredging.

*Money statement.*

| | | |
|---|---|---|
| July 1, 1892, balance unexpended | | $45,668.84 |
| Amount appropriated by act approved July 13, 1892 | | 40,000.00 |
| | | 85,668.84 |
| June 30, 1893, amount expended during fiscal year | | 16,484.64 |
| July 1, 1893, balance unexpended | | 69,184.20 |
| July 1, 1893, outstanding liabilities | $851.79 | |
| July 1, 1893, amount covered by uncompleted contracts | 55,200.00 | |
| | | 56,051.79 |
| July 1, 1893, balance available | | 13,132.41 |
| Amount (estimated) required for completion of existing project | | 269,675.44 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895 | | 200,000.00 |

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

*Abstract of proposals for dredging ship channel in Galveston Bay, Texas, received in response to advertisement dated September 5, 1892, and opened October 5, 1892, by Maj. Charles J. Allen, Corps of Engineers, at Galveston, Tex.*

| No. | Name and address of bidder. | Character of work. | Price. | Amount. |
|---|---|---|---|---|
| 1 | Rittenhouse Moore Dredging Co. | Dredging 230,000 cubic yards of material under water, per cubic yard. | $0.23 | $52,900 |
| | | Excavating slopes of canal banks, 6,000 cubic yards of material above water, per cubic yard. | .25 | 1,500 |
| | | Constructing 2,000 linear feet of sheet piling revetment, per linear foot. | 10.00 | 20,000 |
| | | Total | ........ | 74,400 |

Only one bid received. Rejection recommended.

*Abstract of proposals for dredging ship channel in Galveston Bay, Texas, received in response to advertisement dated January 28, 1893, of Maj. Charles J. Allen, Corps of Engineers, and opened February 28, 1893, by First Lieut. William C. Langfitt, Corps of Engineers, at Galveston, Tex.*

| No. | Name and address of bidder. | Dredging 230,000 cubic yards of material, per cubic yard. | Amount. |
|---|---|---|---|
| | | *Cents.* | |
| 1 | National Dredging Co., Wilmington, Del | 24.9 | $57,270 |
| 2 | Charles Clark, Galveston, Tex | 26¼ | 60,375 |
| 3 | F. A. Hyatt, Beaumont, Tex | 26½ | 60,950 |
| *4 | Rittenhouse Moore Dredging Co., Mobile, Ala | 24½ | 56,350 |

*This bid the lowest and acceptance recommended.

## REPORT OF MR. DONALD ALLEN, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
*Galveston, Tex., June 30, 1893.*

MAJOR: I have the honor to submit the following report of operations for the improvement of ship channel in Galveston Bay, Texas, for the fiscal year ending June 30, 1893.

During August, the notes of the hydrographic survey of the ship channel from Bolivar Channel to and through Morgan Canal were plotted, and the results show the shoaling of the dredged channel goes on at the rate indicated in last annual report as probable, *i. e.*, about 30 per cent of the cut remaining at the end of the last fiscal year; and that—

| | Feet. |
|---|---|
| The ruling depth from Bolivar Channel to Morgan Beacon | 8.6 |
| And the average depth, Bolivar Channel to Morgan Beacon | 9.7 |
| The ruling depth from Morgan Beacon to Morgan Cut | 7.6 |
| And the average depth, Morgan Beacon to Morgan Cut | 8.0 |

Through the canal the depth remains about the same, were correct.

No surveys of the ship channel have been made during the present year.

During September, estimates were made and specifications drawn up for the dredging of Morgan Cut from Morgan Beacon to the mouth of Morgan Canal.

For sloping both banks of Morgan Canal and for building a revetment on the west side of Morgan Canal:

Bids for the above-named work were opened October 5, 1892, and there being only one bidder, and his bid being too high, it was decided to slope the banks of the canal and build the revetment by hired labor, re-advertising the dredging in Morgan Cut.

This was done January 28, 1893, and bids for dredging were opened February 28, 1893, and contract awarded for the work to the Rittenhouse Moore Dredging Company, of Mobile, Ala.

Under this contract work was to be commenced April 25, and be completed October 25, 1893.

Operations under this contract have not begun up to this date, owing to delays in getting the plant ready and an accident happening to the same while in transit to Galveston.

On December 23, 1892, an agreement was entered into with C. W. Wallingford for hire of a force with which to do the work of sloping the banks of Morgan Canal, to consist of four or more scrapers and teams, at $4.25 per team, this price including board of men and teams, and the furnishing of scraper holders and all necessary help, and his general supervision of the work. On January 5, 1893, work was commenced on the east bank of Morgan Canal with a force of four teams, and continued until January 26, when another team was added. On March 11, the grading on the east bank was completed and the teams were transferred across the canal, and work on the west bank commenced and continued until April 7, when the grading was completed. The banks have been cut down to a slope of 1 on 3, except for about 500 feet on the east bank, about midway its length, where the slope was made 1 on 4 in order to afford sufficient space on top for the proposed office and watchman's building.

The amount of material moved and cost was as follows:

| | Cubic yards. |
|---|---|
| East bank | 8,587 |
| West bank | 3,963 |
| Total moved | 12,550 |

At a cost of about $1,570.77, or 12½ cents per cubic yard, this including inspection.

The haul on the east bank was longer than on the west bank, and hardpan was encountered here, which delayed the work somewhat.

On February 22, 1893, the revetment on the west side of Morgan Canal was commenced, and it was completed May 30, 1893. It is 1,959 feet long and cost $5.33 per lineal foot for labor, material, and inspection. The material is sawed yellow heart pine, and it is constructed as follows:

A row of piles, 12 by 12 inches, 32 feet long, is driven parallel to line of canal and on the west side of the same 8 feet centers, with an average penetration of 20 feet in the ground, and standing in an average depth of 7 feet of water. Tops cut off 4 feet 10 inches above mean low tide. On the bank side, and against this line of piling, two lines of stringer pieces of 4 by 8 inches, 16 feet long, are placed, the bottom stringer 3 inches and the top stringer 3 feet 4 inches above mean low tide, respectively.

Against these stringers the sheet piling, 4 by 12 inches, 28 feet long, are driven, their tops standing 4 feet 4½ inches above mean low tide. These sheet piles have an average penetration of 16 feet 7 inches.

On the outside of the sheet piling and next the bank two lines of stringers are placed opposite the two lines of stringers which are against the piles, and the sheet piling between these stringers is held securely in place by inch bolts passing through both sets of stringers and piles.

On the canal or water side of the line of piling a fender consisting of two pieces of 4 by 8 inches, 16 feet long, is spiked to the piles at a height of 3 feet 4 inches above mean low tide for the entire length of the revetment.

Two offsets of sheet piling driven at right angles to the line of revetment connect it with the bank, preventing wave action and currents during high water behind it. The first offset is 573 and the second 1,232 feet from the north end of the revetment.

There was used in the work the following material:

249 12 by 12 inch 32-foot piles.
1,935 4 by 12 inch 28-foot sheet piles.
42 4 by 8 inch 16-foot sheet piles (offsets).
7,996 linear feet 4 by 8 inch stringers.
3,918 linear feet 4 by 8 inch fenders.
500 bolts, 1 inch diameter, 28 inches long.

In order to construct this work it was necessary to hire a barge with steam piledriver and blacksmith shop, for which a compensation of $100 per month was paid.

On the 30th day of May, 1893, the revetment having been completed, the force was transported to Galveston and paid off.

During the month of June, beacons 8. 11, and 14, of ship channel, which had been knocked down by boats, were raised and repaired.

Very respectfully, your obedient servant,

DONALD ALLEN,
*U. S. Assistant Engineer.*

Maj. A. M. MILLER,
*Corps of Engineers, U. S. A.*

## U 3.

## IMPROVEMENT OF CHANNEL IN WEST GALVESTON BAY, TEXAS.

A survey of this locality, with a view to reopening the channel through West Bay to Christmas Point, was made in 1891, in accordance with requirements of sections 13 and 14 of the river and harbor act of August 11, 1888. The results were embodied in a report published in House Ex. Doc. No. 22, Fifty-second Congress, first session.

Congress, by act of July 13, 1892, appropriated as follows:

> Improving channel in West Galveston Bay, in accordance with plan recommended by Major Charles J. Allen, Corps of Engineers, submitted December twelfth, eighteen hundred and ninety, and printed in House Executive Document numbered Twenty-two, Fifty-second Congress, first session, fifteen thousand dollars.

West Bay is an expanse of water between Galveston Island and the mainland, and extends from Galveston Bay to the west end of Oyster Bay.

In 1859 the State of Texas had a channel dredged through the bay, which afforded a navigable depth of 5 feet. This channel remained open until the storm of 1875, which filled it up with sand and small shells until the depth was reduced to from 2½ to 3 feet at mean low tide and was too narrow to allow vessels to pass through except at full tide.

At the time the survey was made in 1891 a ruling depth of 3½ feet at mean low tide was found extending from the railroad bridges across the bay to San Luis Pass. For a considerable distance there was a depth of 5 feet. The ruling depth in Oyster Bay, which forms the western end of Galveston Bay, is 3 feet, except for a short distance, where it is 2.8 feet.

West Bay is connected with the Gulf of Mexico by San Luis Pass, with a depth of 7 to 8 feet, according to U. S. Coast Survey chart, and with Brazos River by the Galveston and Brazos Canal, in which the depth has been dredged to 7 feet. The average rise of the tide is about 1 foot. During the prevalence of northers the depth in the bay is considerably less than that at mean low tide.

In the report on the survey it was stated that navigation would be considerably improved by straightening the channels and removing the points bordering them, and also by dredging, so as to afford a least width of 200 feet and depth of 3½ feet, between the railroad bridges and San Luis Pass in the bay, and a least width of 100 feet and depth of 3 feet along Christmas Point in Oyster Bay, the channel to be suitably marked by beacons.

The estimated cost of the work was $29,000.

The amount appropriated by the act of July 13, 1892, for this improvement was about half the estimated cost, and in the project for its expenditure it was recommended that it be applied, so far as it would go, to widening the channels to 150 or 200 feet, straightening them where required, and deepening them to 3½ feet at mean low tide, excepting along Christmas Point, where a width of 100 feet and depth of 3 feet would suffice for the present, the improved channels to be properly marked by beacons. The dredging to be done by contract and the erection of the beacons by hired labor and purchase of material in open market. This project was approved August 26, 1892.

Proposals for dredging were invited through public advertisement, dated September 5, 1892, the only bid received being that of Branch T. Masterson, Galveston, Tex., which was accepted, the price being considered reasonable, and a contract was entered into with him to do the work, which was to be commenced December 1, 1892, and complete March 31, 1893.

The dredging plant arrived upon the ground on December 9, 1892 but, owing to delay in receiving and repairing machinery and to unfavorable weather, work was not commenced until January 19, 1893 Owing principally to insufficient plant, but little progress was made t March 31, 1893, when a request was made by the contractor for an extension of time to July 31, 1893, which was granted; since then progress has been very slow, as the dredge was constantly breaking down

Up to the close of the fiscal year a channel, 4,168 feet long by 24 t 27 feet wide and having a depth of 3½ feet, was dredged on Dee Island Reef, 2,928 cubic yards of material having been removed in doin this work.

The details of the work are shown in the report of Mr. Donald Allen assistant engineer, which is forwarded herewith.

*Abstract of appropriations.*

| | |
|---|---|
| By act approved July 13, 1892 | $15,00 |

The sum of $14,000 can be profitably expended during the fisca year ending June 30, 1895, in completing the work.

The work is located in the collection district of Galveston, Tex., at which port th revenue collected for the fiscal year ending June 30, 1893, was $132,696.66. Th nearest light-houses are at Half-Moon Reef and Red Fish Bar in Galveston Bay, an at Bolivar and Fort Point, at entrance to Galveston Bay. There are life-saving stations at Fort Point and San Luis Pass.

*Money statement.*

| | | |
|---|---|---|
| Amount appropriated by act approved July 13, 1892 | | $15,000.0 |
| June 30, 1893, amount expended during fiscal year | | 2,317.7 |
| July 1, 1893, balance unexpended | | 12,682.2 |
| July 1, 1893, outstsanding liabilities | $220.00 | |
| July 1, 1893, amount covered by uncompleted contracts | 11,500.00 | |
| | | 11,720.0 |
| July 1, 1893, balance available | | 962.2 |
| Amount (estimated) required for completion of existing project | | 14,000.0 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895 | | 14,000.0 |

Submitted in compliance with requirements of Sections 2 of River and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

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*Abstract of proposals for dredging in West Galveston Bay, Texas, received in respons t advertisement dated September 5, 1892, and opened October 5, 1892, by Maj. Charles J. Allen, Corps of Engineers, at Galveston, Tex.*

[Removing, by dredging, such material as may be necessary, and depositing same as required. Approximate quantity 38,333⅓ cubic yards.]

| No. | Name and address of bidder. | Price per cubic yard. | Approximat amount. |
|---|---|---|---|
| | | *Cents.* | |
| 1 | Branch T. Masterson, Galveston, Tex | 30 | $11,50 |

Only bid received. Acceptance recommended.

## REPORT OF MR. DONALD ALLEN, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
*Galveston, Tex., June 30, 1893.*

**MAJOR**: I have the honor to submit the following report of operations for the improvement of channel in West Galveston Bay, Texas, for the fiscal year ending June 30, 1893:

On September 5, 1892, bids were advertised for dredging a channel from 150 to 200 feet wide and 3½ feet deep in West Galveston Bay at Deer Island, Shell, and Karonkaway, and other reefs, and a channel 100 feet wide and 3 feet deep at Christmas Point.

Bids were opened October 5, 1892, and the contract for this work let to Mr. Branch T. Masterson, of Galveston, Tex., December 1, 1892, the work to be completed by March 31, 1893.

During November and December, 1892, all necessary triangulation stations were erected for locating channel, tide gauges put up, and channel staked out and cross sectioned.

On December 9, 1892, contractor's dredge arrived at Karonkaway, but no dredging was done until January 27, 1893, the time having been spent by the contractor changing his dredging machinery from a chain of buckets to suction, and back to buckets, having found the material was of such character as not to handle by suction.

Only one barge of material was dredged at Karonkaway on January 27, 1892, when, by the request of the contractor, he was permitted to move on January 28 to a point in the channel to be dredged about 1 mile above Deer Island, at which point work was commenced January 30, 1893, working toward the island, and was continued until March 31, 1893, the date of expiration of his contract, a cut 855 feet long by about 26 feet wide having been made between January 30 and March 31, 1893, the very poor progress made being due in small degree to the "northers" and low waters, but most largely due to the continual and almost daily breakage and failure of some part of the machinery, showing the total inadequacy of the plant for the work in hand. By request of the contractor, an extension of time to July 31, 1893, in which to complete his contract was granted.

The total amount of work done to date, June 30, 1893, is a cut dredged in the channel 4,168 feet long, 24 to 27 feet wide, and the removal therefrom of 2,928 cubic yards of material.

No part of the proposed channel having been dredged to its full width and depth, nothing has been paid, as per the contract on this work. The continual breakages in the machinery and long delays in making repairs, and the small amount accomplished in the eight months since this contract was made, convinces me that the contractor can not with this plant complete the work undertaken by July 31, 1893.

Very respectfully, your obedient servant,

DONALD ALLEN,
*U. S. Assistant Engineer.*

Maj. A. M. MILLER,
*Corps of Engineers, U. S. A.*

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## COMMERCIAL STATISTICS OF WEST GALVESTON BAY, TEXAS, FOR FISCAL YEAR ENDING JUNE 30, 1893.

Seven steamers and tugs navigate West Galveston Bay. Length, 39 to 141 feet; draft, 3 feet to 5 feet 6 inches; tonnage from 5 to 240. In addition to this a number of sailing vessels navigate it; a list of their names and dimensions could however not be obtained.

*Amount and value of freight transported.*

| Articles. | Tons. | Approximate value. |
|---|---|---|
| Cotton and cotton seed | 1,810 | $283,560 |
| Lumber | 537 | 15,232 |
| Cattle | 200 | 4,000 |
| General merchandise | 2,350 | 319,685 |
| Total | 4,897 | 622,477 |

## U 4.

## IMPROVEMENT OF TRINITY RIVER, TEXAS.

The Trinity River empties into Galveston Bay through several mouths or passes near its northeast extremity, about 35 miles from Galveston. The relative importance of the passes appears to have varied considerably. The one generally used by vessels of late years is the Middle Pass. The channel depth in the river immediately above the passes is 16 feet or more. The depth in the Middle Pass is 9 feet or more. Opposite the mouth of each of the passes is a bar, the depth upon the crest of that of the Middle Pass being now 3 feet 6 inches. The trade using the river is carried in sailing vessels which draw from 3 feet to 4 feet 8 inches. To accommodate them there should be a channel 5½ feet to 6 feet deep.

It was stated upon page 539 of the Annual Report of the Chief of Engineers for 1871, that Pass A, or the Southeast Pass, was excavated by the Government in 1865 to facilitate the supply of fuel to the troops stationed in Galveston. This improvement was subsequently obliterated by natural causes. In 1880 a channel was dredged across the bar at the mouth of Middle Pass, its length being 4,800 feet, its average width 110 feet, and its least depth 5½ feet, the amount of material removed being 47,300 cubic yards. (See Annual Report Chief of Engineers 1881, p. 1341.) This channel was also obliterated by natural causes. In the winter of 1884 and spring of 1885 a channel was again dredged through the bar at the mouth of Middle Pass to a least depth of 6 feet, its length being 3,750 feet. A wooden revetment was placed upon the west side of the channel for a length of 2,775 feet, and upon the east side for a length of 1,280 feet, the object of which was to prevent the excavated material deposited near by from flowing back into the cut. The Annual Report for 1887 stated that the channel had shoaled in some places, that additional dredging was needed, and that the revetment required repairs and extension. The cost of the necessary work was estimated at $25,000.

An appropriation of $12,500 for continuing the improvement having been made in the river and harbor act of August 11, 1888, a survey was undertaken in April following to ascertain the condition of the bar and of the works executed for its improvement in 1884–'85.

The condition of the old works and bar, as found from that survey, is stated as follows in the Annual Report for 1889:

> The channel, though not obliterated, has shoaled considerably and had a least depth at one point of only 3 feet 2 inches. The west revetment is in fair condition for a length of 1,800 feet from its upstream end, the remaining 975 feet being much damaged. The east revetment is in good condition for a length of 300 feet from its downstream end; of the remainder only the piles remain. Evidence of the action of the teredo is found in the downstream end of the west revetment, but for most of the distance the wood appears to have been protected by the presence of fresh water.

From the results of the survey it appeared best to construct two parallel jetties of timber, to extend from the mouth of the Middle Pass across the bar and into 6 feet depth of water in Galveston Bay and to close, by means of submerged dams or sills, the other principal passes, the jetties to be placed about 275 feet apart and to have a total length of 15,350 feet; the length of the west jetty to be 7,750 feet and that of the east jetty 7,600 feet; as much of the old work as might be serviceable to be embodied in the west jetty.

The total cost of the foregoing, including removal of so much of the east revetment as might remain after completion of the work, was placed at $55,000. This plan and estimate was approved in 1889. Adding to the foregoing sum the amounts expended for dredging, etc., under former appropriations the revised estimated cost of the improvement was brought up to $89,500.

Under the appropriation made by act of August 11, 1888, 3,269 linear feet of west jetty was built. The result of the work was a slight deepening in the channel running parallel with the line of new jetty, an increase in depth on the bar of about 4 inches, and a straightening of the channel, making the crossing of the bar easier than it was before the improvement commenced in 1889.

Congress, by act approved September 19, 1890, appropriated $10,000 for continuing the improvement. This sum was applied to construction of 1,360½ linear feet of west revetment, sufficient to join it to the old revetment, which was also repaired for a distance of 1,530 feet, the aggregate length of west jetty, as now completed, being 6,159 feet.

During the present fiscal year no work was done beyond making an examination and survey of the river at its mouth, with a view to preparing a project for the expenditure of the amount ($10,000) appropriated by act of July 13, 1892. This project will be submitted as soon as possible.

The depth on the bar remains practically the same as it was last year, viz, 3½ feet at mean low tide.

The amount required to complete the work is $22,500, which can be profitably expended during the fiscal year ending June 30, 1895.

A special agent was employed during the year to keep a record of the commerce and tonnage of the river. Statistics compiled from his report are herewith. It appears from the comparative statement of statistics that the shipment of freight during the past fiscal year is slightly less than that for the preceding year.

| | |
|---|---|
| Amount expended to include June 30, 1892 | $56,119.68 |
| Amount expended during the past fiscal year | 627.25 |
| Total expended upon the improvement to include June 30, 1893 | 56,746.93 |

*Abstract of appropriations made by Congress for improving Trinity River, Texas.*

| | |
|---|---|
| By act approved— | |
| June 18, 1878 | $10,000 |
| March 3, 1879 | 2,500 |
| June 14, 1880 | 4,000 |
| March 3, 1881 | 10,000 |
| By act passed August 2, 1882 | 8,000 |
| By act of August 11, 1888 | 12,500 |
| By act approved— | |
| September 19, 1890 | 10,000 |
| July 13, 1892 | 10,000 |
| Total | 67,000 |

Of this amount the sum of $7,500 was expended in 1882 in removing obstructions between Liberty and the mouth of the river.

The sum of $22,500 can be profitably expended during the fiscal year ending June 30, 1895, in completing the work.

The work is located in the collection district of Galveston. The nearest lighthouse is at Red Fish Bar. The amount of revenue collected at the port of Galveston for the fiscal year ending June 30, 1893, was $132,696.56.

*Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $880.32 |
| Amount appropriated by act approved July 13, 1892 | 10,000.00 |
| | 10,880.32 |
| June 30, 1693, amount expended during fiscal year | 627.25 |
| July 1, 1893, balance unexpended | 10,253.07 |
| July 1, 1893, outstanding liabilities | 60.18 |
| July 1, 1893, balance available | 10,192.89 |
| Amount (estimated) required for completion of existing project | 22,500.00 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895 | 22,500.00 |

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

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COMMERCIAL STATISTICS OF TRINITY RIVER, TEXAS, FOR THE FISCAL YEAR ENDING JUNE 30, 1893.

Vessels using the river, 32 (27 sailing vessels, 3 barges, and 2 steamers); length on deck, 25 feet to 150 feet; draft, 2 feet 6 inches to 5 feet 6 inches; tonnage, 5 tons to 150 tons; trips made during the year, 1,115; total tonnage, 15,641 tons.

*Amount and value of freight transported.*

| Articles. | Tons. | Approximate value. | Approximate freight charges. |
|---|---|---|---|
| Cotton | 217 | $9,798 | $315 |
| Lumber | 8,933 | 26,432 | 10,072 |
| General merchandise | 319 | 16,677 | 1,310 |
| Total | 9,469 | 52,907 | 11,697 |

Decrease since last year 115 tons.

*Comparative statement of commercial statistics of Trinity River, Texas, for the fiscal years ending June 30, 1888, 1889, 1890, 1891, 1892, and 1893.*

| Year. | Vessels using river. | Maximum length. | Maximum draft. | Maximum tonnage. | Trips made. | Total tonnage. | Transported. | | | | Total value of cargoes. | Total freight charges. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Cotton. | Lumber. | General merchandise. | Total weight. | | |
| | *No.* | *Feet.* | *Feet.* | *Tons.* | *No.* | *Tons.* | *Tons.* | *Tons.* | *Tons.* | *Tons.* | | |
| 1888 | 32 | 65 | 4.7 | 32 | 1,217 | 15,958 | 226 | 11,863 | 855 | 12,944 | $88,704 | $17,027 |
| 1889 | 36 | 65 | 4.5 | 32 | 1,330 | 16,737 | 148 | 10,872 | 1,159 | 12,179 | 75,902 | 17,276 |
| 1890 | 33 | 80 | 5.5 | 80 | 1,221 | 16,887 | 102 | 10,906 | 719 | 11,727 | 46,347 | 14,249 |
| 1891 | 30 | 80 | 5.5 | 80 | 1,115 | 15,733 | 38 | 9,364 | 552 | 9,954 | 47,034 | 13,582 |
| 1892 | 30 | 120 | 5.6 | 150 | 1,100 | 13,994 | 37 | 8,753 | 794 | 9,584 | 61,810 | 13,049 |
| 1893 | 32 | 150 | 5.6 | 150 | 1,115 | 15,641 | 217 | 8,933 | 319 | 9,469 | 52,907 | 11,697 |

## U 5.

### IMPROVEMENT OF CEDAR BAYOU, TEXAS.

A survey of this locality, with a view to the removal of the bar at the mouth of the bayou was made in 1889, and the first appropriation for its improvement was embodied in the river and harbor act of Septem-19, 1890.

Cedar Bayou discharges into the northwest corner of Galveston Bay, at a point about 1½ miles from the mouth of San Jacinto River and distant about 28½ miles from Galveston.

The general width of the bayou near its mouth is 250 feet, and the depth, inside the bar at its mouth, 7 feet, and the ruling depth over the bar, at mean low tide, is 3 feet.

The approved project for the improvement of this stream consists in deepening the channel on the bar by dredging, so as to afford a depth of 5 feet at mean low tide, the width of the cut to be about 100 feet. This cut to be protected by brush and stone walls or jetties, rising to a height of about 2½ feet above mean low tide. The total length of the walls, which were to extend across the bar to a depth of 5 feet in Galveston Bay, was about 5,000 feet. The estimated cost of the work as revised in 1891 was $32,150. Experience, however, has proved that this amount was too small, and it is estimated that it will require the further sum of $6,500 to complete it, thus making the total cost $38,750.

The work was first undertaken by contract, but owing to the failure of the contractors to complete it, it was continued by hired labor and purchase of material and procuring dredge work in open market.

At the close of last fiscal year 3,459 feet of jetties had been built, of which 2,370 feet on the south jetty requires raising about 1½ feet, and a channel had been dredged on the bar which was 1,840 feet long, 64 feet wide, and which had a ruling depth of 5 feet at mean low tide. The ruling depth over the approaches to the cut was 4 feet, which was an increase in depth of about 1 foot, due to the above work. Operations were suspended June 30, 1892, the funds available being nearly exhausted.

An appropriation of $14,000 having been made for this work by the river and harbor act of July 13, 1892, a project was submitted for its expenditure which consisted in continuing the jetties by hired labor and purchase of material in open market, and doing necessary dredging by contract.

The project having been approved work was resumed on the jetties October 9, 1892, and continued to January 21, 1893, when the funds available for this part of the work were expended. The south jetty was extended a distance of 517 feet, and the north jetty a distance of 325 feet. The total length of the north jetty is now 1,413 feet, and that of the south jetty 2,888 feet; 1,371 feet of this latter requires raising about 1½ feet in order to complete it.

The details of the season's operations are shown in the report of Mr. R. B. Talfor, assistant engineer, which is forwarded herewith. No dredging was done during the year, as it was deemed most advisable to first construct the jetties, in order to let them cut the bar away as much as possible, and as, after they were completed, it would be known just about how much money would be available for dredging. Proposals for doing the necessary dredging will be invited and work will be commenced as soon as practicable. In order to reach the 5-foot curve in the bay it will be necessary to extend the cut previously dredged on the bar about 1,000 feet; the north jetty will also have to be extended about 400 feet, and the south jetty about 600 feet; this will complete the project.

| | |
|---|---|
| Amount expended to June 30, 1892 | $13,258.22 |
| Amount expended during fiscal year | 11,220.23 |
| Total expended to June 30, 1893 | 24,478.45 |

*Abstract of appropriations made for this work.*

| | |
|---|---|
| By act of September 19, 1890 | $18,150.00 |
| By act of July 13, 1892 | 14,000.00 |
| Total | 32,150.00 |

The sum of $6,500 can be profitably expended during the fiscal year ending June 30, 1895, in dredging and construction of brush and stone walls.

The work is located in the collection district of Galveston. The nearest lighthouse is at Red Fish Bar.

*Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $4,891.78 |
| Amount appropriated by act approved July 13, 1892 | 14,000.00 |
| | 18,891.78 |
| June 30, 1893, amount expended during fiscal year | 11,220.23 |
| July 1, 1893, balance unexpended | 7,671.55 |
| Amount (estimated) required for completion of existing project | 6,500.00 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895 | 6,500.00 |
| Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893. | |

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### REPORT OF MR. R. B. TALFOR, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
*Galveston, Tex., June 30, 1893.*

MAJOR: I have the honor to make the following report on the Cedar Bayou improvement for the fiscal year ending June 30, 1893:

The project for this work comprises the construction of two jetties of stone and brush about 250 feet apart where they cross the bar, to be extended to the 5-foot contour outside the bar. These jetties are to protect a channel of 5 feet depth to be dredged between them from the 5-foot curve outside to 5-foot curve inside the bayou; width of dredged channel to be about 100 feet.

In obedience to instructions from Maj. Chas. J. Allen, Corps of Engineers, U. S. Army, I left Galveston, October 9, 1892, on the schooner *Louis Dalson*, with a party of 10 men and proceeded to Cedar Bayou and that night established a temporary camp, and on the following day commenced actual operations by clearing the point on the south side of the bayou for a construction ground for mattress work, from which time till cessation of work, January 22, 1893, work on the jetties was as continuous as practicable. The progress of the work was considerably retarded by the unusually bad weather, low tides, and lack of promptness, on the part of the contractors, in delivery of materials, which also accounts for the comparative costliness of the work, the men being paid by the month and no deduction made for necessarily lost time. The plant, tools, etc., had to be purchased.

The work was commenced under contract during the preceding fiscal year but was abandoned by the contractors February 22, 1892, and continued this year by the Department; no contract having been let except for the necessary material and supplies.

The following comprises the work during the year: The north jetty was extended 325 feet, 8 mats 40 by 23 feet being used, and the south jetty 517 feet, 13 mats having been placed, 12 mats 40 by 23 feet, and 1 mat 13½ by 23 feet.

This 842 feet of new work was covered and raised 1¼ feet above mean low tide with 665.34 cubic yards of stone, making total length of north jetty, completed, 1,413 feet, and a total of completed south jetty 1,517 feet; 1,371 linear feet of south jetty is still unfinished and it is estimated that about 300 cubic yards of stone is required to raise it to the height of the balance of the work, *i. e.*, 1¼ feet above mean low tide.

The 21 mats placed in the jetties this year were constructed same as last with this exception: instead of fascines, bundles of brush were substituted for filling and the center of the mat made about 3 feet thick, the edges being about 1 foot thick. This additional height to the center of the mat obviated the use of an upper course of mats, thereby making a saving in material and time used in towing them into position.

Cross sections were made at every 200 feet over both jetties, the soundings made at every 5 feet marked on a wire line stretched 250 feet on each side, giving a total of about 500 feet for each cross section. Each cross section was located by measurements along the crest of the jetties, also by sextant angles, the line of cross section being normal to line of jetty.

These sections show an improvement in the channel dredged last year. See chart, also letters from captains of vessels employed in the bayou trade.

There still remains considerable dredging to be done to extend the cut to the 5-foot depth outside and to widen the channel way to 100 feet, the present dredge width being about 60 feet, with a depth of 5¼ feet at mean low tide. Outside the outer end of the cut there is about 4¼ feet at mean low tide.

From this end out the cut will have to be extended about 1,000 feet, 100 feet wide, to reach the 5-foot curve in the bay. To reach the same curve the north jetty will have to be extended about 400 feet and the south jetty about 600 feet.

A compression or settlement of from three to six-tenths of a foot has taken place over a portion of the south jetty. The north one showing not more than about two-tenths settlement.

The south jetty, owing to its location, ought to be raised 1¼ feet more, making it at least 2½ feet above mean low tide, it being exposed to wave action from the bay during the prevalence of winds from the southeast and southwest quadrants.

This work, with that already enumerated, will complete the project.

Beacons have been placed at the outer ends of both jetties, that on the north painted black, on the south red.

The following shows the amount of material used and cost of same placed in jetties:

*Old work.*—Seven hundred and fifty cubic yards of stone was distributed over about 1,477 feet of south jetty at a cost of $3.38 per cubic yard.

*New work.*—Eight hundred and forty-two linear feet of jetty was constructed at a cost of $5.46 per linear foot. The material used in this work consisted of 665.34 cubic yards of stone and 419.3 cords of brush, the cost as placed in the jetty being, for stone, $3.43 per cubic yard, and for brush, $5.53 per cord.

Very respectfully,

R. B. TALFOR,
*Assistant Engineer.*

Maj. A. M. MILLER,
*Corps of Engineers, U. S. A.*

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## COMMERCIAL STATISTICS OF CEDAR BAYOU, TEXAS, FOR THE FISCAL YEAR ENDING JUNE 30, 1893.

Vessels using the bayou, 15 (8 sailing vessels, 5 barges, and 2 steam tugs); draft, 3 feet to 4 feet 6 inches; tonnage, 8 tons to 135 tons; trips made during the year, 986; total tonnage, 28,777 tons.

*Amount and value of freight transported.*

| Articles. | Tons. | Approximate value. | Approximate freight charges. |
|---|---|---|---|
| Brick | 15,920 | $55,720 | $11,389 |
| Cotton | 75 | 10,000 | 150 |
| General merchandise | 4,975 | 73,300 | 4,747 |
| Total | 20,970 | 139,020 | 16,286 |

Increase since last year, 928 tons.

*Comparative statement of commercial statistics of Cedar Bayou, Texas, for the fiscal years ending June 30, 1891, 1892, and 1893.*

| | Vessels using bayou. | Maximum draft. | Maximum tonnage. | Trips made. | Total tonnage. | Freight transported. | Total value of freight. | Total freight charge. |
|---|---|---|---|---|---|---|---|---|
| | *No.* | *Feet.* | *Tons.* | *No.* | *Tons.* | *Tons.* | | |
| 1891 | 18 | 3½ | 96 | ........ | ........ | 19,250 | $108,250 | $18,612 |
| 1892 | 16 | 4½ | 96 | 1,060 | 26,940 | 20,042 | 128,250 | 18,113 |
| 1893 | 15 | 4½ | 135 | 996 | 20,777 | 20,970 | 139,020 | 16,286 |

## U 6.

## IMPROVEMENT OF BUFFALO BAYOU, TEXAS.

Buffalo Bayou is a tide-water stream, emptying into San Jacinto River at Lynchburg, about 25 miles below Houston and about 8 miles above the junction of the San Jacinto with Galveston Bay. White Oak and Simms bayous are tributaries, the former entering at Houston and the latter at a point about 11 miles below.

A survey of the bayou, with a view to its improvement, was made in 1871, and a subsequent examination between White Oak and Simms bayous was made in 1880. The estimated cost of obtaining a channel 100 feet wide and 12 feet deep in this stream, as stated in the report on the examination, was $385,299.75.

The object of the improvement is to secure for Buffalo Bayou a channel having the same dimensions (100 feet wide and 12 feet deep) as the one contemplated for Galveston Bay, the aim being to admit seagoing ships to Houston. These dimensions of channel exist naturally in Buffalo Bayou below Simms Bayou and in the San Jacinto River, though it is reported that a small bar exists in San Jacinto River near Morgan Canal.

Morgan Canal is the name given to a channel excavated by the Buffalo Bayou Ship Channel Company through Morgan Point, a peninsula at the mouth of San Jacinto River. In Galveston Bay, in prolongation of the canal, is Morgan Cut, also executed by the same company, connecting it with the ship channel dredged in the bay by the United States. The canal and cut now belong to the United States.

It is between White Oak and Simms bayous that improvement of Buffalo Bayou is almost entirely needed. The banks here are high and generally stable, though occasionally subject to landslides. The surface width is generally greater than 100 feet, though there are some exceptions to this rule. The depth in the middle of the channel is usually 9 feet or more at ordinary tides, but there are occasional shoals upon which as little as 5 or 6 feet is found, and during northers the water surface is sometimes lowered several feet. At some points navigation is obstructed by the sharpness of the bends. It is endangered also by sunken logs and stumps in the bed of the stream and by overhanging trees upon the banks.

The commerce of the bayou is important. It is mostly carried on by means of barges towed by tugs. The draft of the latter is 7 feet or less; that of the former, when fully loaded, about 5 feet.

Even if but partial improvement of the channel be made with the sums appropriated, so as to secure 9 or 10 feet of water at mean low tide, the resulting benefit will be not only immediate but great, and this benefit will be increased by easement of bends and removal of snags, trees, etc. When a 12-foot depth is maintained throughout from Bolivar

Channel to Morgan Cut and Canal, and through the latter to San Jacinto River, the depth of Buffalo Bayou can be correspondingly increased as appropriations are made.

A new supply of sunken logs is found annually in Buffalo Bayou, and considerable shoaling from surface wash also occurs annually.

The first appropriation for the improvement of this stream was made in 1881, and subsequent appropriations have been added from time to time. The money has been applied to dredging, easing of bends, and in removal of stumps, logs and overhanging trees. This work has been of great benefit to the navigation of the stream, enabling boats drawing 7 feet of water to reach Houston without difficulty.

An appropriation of $25,000, was made for this work in the river and harbor act of July 13, 1892, and it was recommended that it be expended in dredging the bars to a depth of 10 feet at mean low tide, in easing the sharpness of bends, and in removing leaning trees, sunken logs, and other obstructions.

This project having been approved, proposals for dredging and removal of obstructions were advertised for on September 5, 1892, the bids to be opened on October 5, 1892. No proposals were, however, received in response to this advertisement. The work was re-advertised January 28, 1893, bids to be opened February 28, 1893. Two proposals were received in response to this advertisement, and it was recommended and approved that the bid of Lockwood Meggett, of Houston, Tex., be accepted. A contract was made with him March 16, 1893, and work was commenced April 1, 1893, and continued until the close of the fiscal year, at which time the contractor had accomplished the following amount of work: 23,358 cubic yards of material dredged under water, 99 sunken logs and 84 stumps were removed, and 1,005 overhanging trees were cut down.

The details of the season's operations are shown in the accompanying report of Mr. R. B. Talfor, assistant engineer, to which attention is invited.

The trade of the bayou is principally carried on by the Houston Direct Navigation Company with tugs and barges, but many small vessels visit it. To ascertain the extent of this trade, a special agent was employed to keep a daily record of the commerce and tonnage of the bayou. Large shipments of cotton are made from Houston to Galveston by water, to be loaded on seagoing vessels at the latter place. The number of bales shipped down the bayou during the present fiscal year was 279,316.

| | |
|---|---|
| Amount expended to include June 30, 1892 | $165,803.99 |
| Amount expended during present fiscal year | 7,413.99 |
| Total amount expended to June 30, 1893 | 173,217.98 |

It is estimated that the sum of $50,000 can be profitably expended during the fiscal year ending June 30, 1895, in continuing the improvement by again going over the ground, more or less, where dredging has been done; in widening the waterway where the surface width is less than 100 feet and where the cost of widening is not excessive, and where the banks will bear such widening without danger of sliding; in deepening the channel where its depth is less than 10 feet; in easing the bends and in removal of logs, stumps, etc.

The work is located in the collection district of Galveston. The nearest lighthouses are those in Galveston Bay. The amount of revenue collected at the port of Galveston for the fiscal year ending June 30, 1893, is $132,696.66.

*Abstract of appropriations made by Congress for improving Buffalo Bayou, Texas.*

| | |
|---|---|
| By act approved March 3, 1881 | $25,000 |
| By act passed August 2, 1882 | 50,000 |
| By act approved July 5, 1884 | 25,000 |
| By act approved August 5, 1886 | 18,750 |
| By act of August 11, 1888 | 25,000 |
| By act approved September 19, 1890 | 25,000 |
| By act approved July 13, 1892 | 25,000 |
| Total | 193,750 |

## *Money statement.*

| | | |
|---|---|---|
| July 1, 1892, balance unexpended | | $2,946.01 |
| Amount appropriated by act approved July 13, 1892 | | 25,000.00 |
| | | 27,946.01 |
| June 30, 1893, amount expended during fiscal year | | 7,413.99 |
| July 1, 1893, balance unexpended | | 20,532.02 |
| July 1, 1893, outstanding liabilities | $4,633.07 | |
| July 1, 1893, amount covered by uncompleted contracts | 11,957.98 | |
| | | 16,591.05 |
| July 1, 1893, balance available | | 3,940.97 |

| | |
|---|---|
| Amount (estimated) required for completion of existing project | 191,549.75 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895 | 50,000.00 |

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

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*Abstract of proposals for dredging and removal of obstructions in Buffalo Bayou, Texas, received in response to advertisement dated January 28, 1893, by Maj. Charles J. Allen, Corps of Engineers, and opened February 28, 1893, by First Lieut. William C. Langfitt, Corps of Engineers, at Galveston, Tex.*

| No. | Name and address of bidder. | Character of work. | Price. | Amount. |
|---|---|---|---|---|
| *1 | Enoch Townsend and C. W. Johnstone, Somers Point, N. J | | | |
| †2 | Lockwood Meggett, Houston, Tex. | Dredging 50,000 cubic yards, more or less, material under water......per cubic yard | $0.40 | $20,000.00 |
| | | Dredging and scraping 15,000 cubic yards, more or less, of material under water, per cubic yard | .31 | 4,650.00 |
| | | Removing 500 cubic feet, more or less, sunken logs per cubic foot | .07½ | 37.50 |
| | | Removing 5,000 cubic feet, more or less, of overhanging and dead trees, per cubic foot | .06¼ | 312.50 |
| | | Removing such stumps and wrecks as may be necessary, per hour | 14.85 | |
| | | Total | | 25,000.00 |

* This bid not considered, as it contains only a lump sum bid of $5,500 for removing "500 cubic feet, more or less, of sunken logs; 5,000 feet, more or less, of overhanging and dead trees, and the 100 stumps and wrecked scow."

† Lowest bid considered and recommended for acceptance, the absence of seals after signature being an informality that the United States has the right to waive.

## REPORT OF MR. R. B. TALFOR, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
*Galveston, Tex., June 30, 1893.*

MAJOR: I have the honor to report as follows on the Buffalo Bayou improvement for the fiscal year ending June 30, 1893:

In obedience to your orders. dated Galveston, Tex., March 22, 1893, and received same date, I left Galveston on March 25, 1893, accompanied by Mr. B. O. Harrison, who was appointed inspector, and arrived in Houston the same day.

I immediately assumed charge and the next day staked off work and made the necessary cross-sections of the bayou near Lipkee's place, about one-fourth mile up stream from Arkansas Bend, and 3¼ miles from Houston (see sketch), where the contractors commenced work on Monday, April 3, with Plant No. 1, consisting of one Osgood dredge, one steam derrick and scow, and one boarding-house boat.

About 600 linear feet of the bayou was dredged to a ruling depth of 10 feet and a width varying from 50 to 60 feet; numerous logs and stumps were removed from the bed of the bayou. On the 25th instant this work was completed and the plant moved to near the Inman, or "New Compress," and on the following day similar work was commenced and prosecuted continuously till June 1. On May 19 Plant No. 2, being similar to No. 1, was put to work at the "Cleveland Compress" making an excavation on the left bank of the bayou 200 feet long to facilitate the landing of cotton barges at said press. A bulkhead is now being built here by the compress owners, and is expected to be completed in a few days. On June 1 both plants were moved to Arkansas Bend, 3¼ miles below Houston, and on the following day began operations, and the work at this point was completed this month, thus finishing the work of the dredges for the fiscal year.

On April 2 a small force was put to work removing overhanging trees, and have worked almost continuously to date from a point 5 miles below Houston up to the International and Great Northern Railway bridge, at points where trees impeded navigation the most, notably at Arkansas and Turkey bends.

The dredging, tree-cutting, etc., at Arkansas bend was very much needed, and was complained of by masters of vessels engaged in the Bayou trade. It is now as easy of navigation as any of the bends between Houston and Harrisburg.

The appropriation not yet being exhausted, the balance available will be expended on the worst places between the San Antonio and Arkansas Pass Railway bridge and Houston, as this portion is the most difficult of navigation.

The amount of work done on Buffalo Bayou during the season was as follows:

| | |
|---|---|
| Dredged 23,358 cubic yards material, at 40 cents per cubic yard | $9,343.20 |
| Removed 99 logs, containing 2,277 cubic feet, at 7½ cents per cubic foot | 170.77 |
| Removed 1,005 trees, containing 16,451 cubic feet, at 6¼ cents per cubic foot | 1,028.19 |
| Removed 84 stumps, requiring 41 hours and 30 minutes' time of plant, at $14.85 | 616.27 |
| Total | 11,158.43 |

The work on many portions of the bayou might be made much more permanent by constructing bulkheads at the various gulleys and drains emptying into the stream, with a suitable drain placed in the upper part of said bulkhead and extending back into the gulley, so as to allow material conveyed in suspension to deposit back of the bulkhead, and the water from the surface to empty into the bayou. As the settlement back of the bulkhead extended up the gulley, the drain might be also extended in advance of the deposit and above it.

Natural drains might be thus treated at Government expense, and the others by the city, county, and private individuals or corporations who own or use them. The attention of the Department has been called to this matter (see Annual Report of Chief of Engineers, 1884, part 2, page 1307), but I deem it of sufficient importance to admit of reiteration.

Very respectfully,

R. B. TALFOR,
*Assistant Engineer.*

Major A. M. MILLER,
*Corps of Engineers, U. S. A.*

### COMMERCIAL STATISTICS OF BUFFALO BAYOU, TEXAS, FOR THE FISCAL YEAR ENDING JUNE 30, 1893.

Vessels using the bayou: Forty barges, length 38 to 162 feet; draft 3 to 6 feet; tonnage, 23 to 358 tons. Eight steam tugs, length, 50 to 94 feet; draft, 4 to 6¼ feet; tonnage, 12 to 105 tons. Three steamers, length, 57 to 145 feet; draft, 4 to 4½ feet; tonnage, 26 to 240 tons. Sixty-one schooners and sloops, length, 24 to 144 feet; draft, 2 to 8 feet; tonnage, 4 to 413 tons each. Trips made during the year, 2,587. Total tonnage, 303,764 tons.

*Amount and value of freight transported.*

| Articles. | Tons. | Approximate value. | Approximate freight charges. |
|---|---|---|---|
| Cotton (279,816 bales) | 69,829 | $11,998,625 | $130,880 |
| Cotton-seed cake and meal | 10,767 | 225,123 | 11,290 |
| Coal and wood | 8,343 | 35,328 | 6,546 |
| Lumber and shingles | 1,001 | 10,769 | 2,220 |
| General merchandise | 16,706 | 567,049 | 24,814 |
| Total | 106,646 | 12,836,894 | 175,750 |

Decrease since last year, 25,533 tons.

*Comparative statement of commercial statistics of Buffalo Bayou, Texas, for the fiscal years ending June 30, 1888, 1889, 1890, 1891, 1892, and 1893.*

VESSELS USING BAYOU.

| Year. | Schooners. | Steamers. | Barges. | Maximum length. | Maximum draft. | Maximum tonnage. | Trips made. | Total tonnage. |
|---|---|---|---|---|---|---|---|---|
| | *No.* | *No.* | *No.* | *Feet.* | *Feet.* | *Tons.* | *No.* | *Tons.* |
| 1888 | 62 | 7 | 20 | 173 | 8 | 254 | 920 | ........ |
| 1889 | 38 | 7 | 19 | 173 | 7 | 254 | 735 | ........ |
| 1890 | 42 | 7 | 19 | 173 | 7 | 254 | 617 | ........ |
| 1891 | 33 | 4 | 31 | 162 | 6 | 358 | 2,274 | 295,869 |
| 1892 | 71 | 11 | 32 | 162 | 6½ | 358 | 3,345 | 398,452 |
| 1893 | 61 | 11 | 40 | 162 | 8 | 413 | 2,587 | 303,764 |

TRANSPORTED.

| Year. | Cotton. | Cotton-seed cake. | Wood and coal. | Lumber and shingles. | Iron and steel. | General merchandise. | Total weight. | Total value. | Total freight charges. |
|---|---|---|---|---|---|---|---|---|---|
| | *Tons.* | *Tons.* | *Tons.* | *Tons.* | *Tons.* | *Tons.* | *Tons.* | | |
| 1888 | 26,692 | 9,959 | 4,320 | 2,765 | 1,509 | 4,596 | 49,841 | $5,132,323 | $94,96 |
| 1889 | 41,227 | 12,628 | 3,456 | 1,221 | 1,120 | 898 | 60,550 | 7,617,380 | 98,79 |
| 1890 | 66,852 | 19,199 | 2,970 | 512 | 1,278 | 5,423 | 96,234 | 13,880,766 | 154,71 |
| 1891 | 81,548 | 12,469 | 9,810 | 622 | ........ | 3,639 | 108,088 | 16,243,395 | 156,90 |
| 1892 | 84,189 | 21,750 | 15,595 | 1,538 | ........ | 9,112 | 132,179 | 13,790,650 | 206,71 |
| 1893 | 69,829 | 10,767 | 8,343 | 1,001 | ........ | 16,706 | 106,646 | 12,836,894 | 175,75 |

## U 7.

## IMPROVEMENT OF HARBOR AT BRAZOS SANTIAGO, TEX.

The work of construction for improvement of this harbor was suspended in October, 1884. The subject of the improvement of the harbo was referred by the Chief of Engineers, under date of December 8 1885, to the Board of Engineers for report. The Board called for certain information which involved a resurvey of the harbor and othe investigations. A surveying party left Galveston on the 24th of Jun 1887, to procure the desired information, completing the survey earl in August following. The results of the survey were reported under date of September 29, 1887. The report showed that the work (south jetty) completed in 1884 had practically disappeared. The project under which that jetty had been built contemplated the construction of two parallel jetties, as follows: The south jetty (Brazos Island Jetty) to be 3,630 feet long and the north jetty (Padre Island Jetty) to be 2,940 feet; the direction of the jetties to be in prolongation of the pass, the width between them to be about the same as that of the narrowest part of the pass, viz, 1,500 feet; estimated cost of the north jetty, about $130,000; estimated cost of the south jetty, about $190,000. In addition it had been proposed to construct a dam from Point Isabel to Brazos Island to increase the depth of water on the bar and in the channel to Point Isabel by preventing the flow towards Boca Chica. Approval had been given to so much of the project as covered the construction of the south jetty. For information in detail as to the condition of the work and cost of further improvement reference is here made to the report of September 29, 1887, and to that of the Board of Engineers, both contained in Appendix T to the Annual Report of the Chief of Engineers for 1888, pp. 1322–1330 and pp. 1299, 1300.

From the best information attained by the survey the cost of an improvement to consist of two parallel jetties placed about 1,100 feet apart was estimated at not less than $1,130,000, and it was also estimated, in the Annual Report for 1888, that the appropriation necessary for carrying on that work (should it be ordered) for the fiscal year ending June 30, 1890, should not be less than $600,000. The total of expenditure under appropriations at the date of rendering the estimate of $1,130,000 was $188,590.23, so that the revised estimate of cost of the improvement, counting from the commencement of the work, was thus brought up to $1,318,590.23.

The total of appropriations to include the last one, that of $25,000, by act of August 11, 1888, is $247,500. The expenditures since work ceased in 1884 have amounted to $5,134.87 in making survey and in contingencies, including in the latter the cost of collecting commercial statistics of the port.

No work for improvement was done during the past fiscal year, the amount of money available having been too small to warrant commencing it. A special agent was employed during the year to keep a daily record of all incoming and outgoing trade.

Commercial statistics compiled from this record are hereto appended. It will be seen that the trade of the port is comparatively light. Comparison of this with records of last year shows a decrease of tonnage of 72 tons.

The conclusion that not less than $600,000 should be available before undertaking further work is here concurred in, though it is not asserted that the amount of commerce to be benefited justifies such an expenditure at this time. And it is respectfully suggested that if the importance of the port be not considered sufficient to justify so large an appropriation the improvement be deferred for the present. There remain in round numbers $543,000 as the sum that should be appropriated for the fiscal year ending June 30, 1895, in case Congress orders the improvement indicated.

| | |
|---|---|
| Original estimated cost of the work as revised in 1888 | $1,318,590.22 |
| Aggregate amount appropriated to July 1, 1892 | 247,500.00 |
| Amount expended to July 1, 1892 | 189,798.59 |
| Amount expended during the past fiscal year | 60.00 |
| Total expended to July 1, 1893 | 189,858.59 |

In addition there was appropriated in 1878 $6,000, which was to removing a wreck.

The work is located in the collection district of Brownsville. The neare house is the Brazos Santiago light-house on Padre Island.

*Abstract of appropriations made by Congress for improving harbor at Brazos Tex.*

By act approved—
 June 14, 1880
 March 3, 1881
By act passed August 2, 1882
By act approved—
 July 5, 1884
 August 5, 1886
By act of August 11, 1888

 Total

*Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $57, |
| June 30, 1893, amount expended during fiscal year | |
| July 1, 1893, balance unexpended | 57, |
| July 1, 1893, outstanding liabilities | |
| July 1, 1893, balance available | 57, |
| Amount (estimated) required for completion of existing project | 1, 071, |
| Amount that can be profitably expended in fiscal year ending June 30, 1895 | 543, 0 |
| Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893. | |

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COMMERCIAL STATISTICS OF BRAZOS SANTIAGO, TEX., FOR THE FISCAL YEAR EN JUNE 30, 1893.

Vessels using the harbor, 21 (5 steamers and 16 sailing vessels). Length on 26 feet to 220 feet; draft, 2 feet 6 inches to 9 feet 4 inches. Tonnage, 5 tons t tons. Trips made during the year, 158. Total tonnage, 44,927 tons.

*Amount and value of freight transported.*

| Articles. | Tons. | Approximate value. | Approxi freigh charge |
|---|---|---|---|
| Wool and hides | 2, 460 | 123, 450 | $1 |
| Lumber | 2, 243 | 28, 303 | 1 |
| General merchandise | 12, 711 | 659, 536 | 13 |
| Total | 17, 423 | 811, 289 | 15 |

Decrease since last year, 72 tons.

*Comparative statement of commercial statistics of Brazos Santiago Harbor, Texas, for the fiscal years ending June 30, 1888, 1889, 1890, 1891, 1892, and 1893.*

| Year. | Vessels using harbor. | Maximum length. | Maximum draft. | Maximum tonnage. | Trips made. | Total tonnage. |
|---|---|---|---|---|---|---|
| | *No.* | *Feet.* | *Feet.* | *Tons.* | *No.* | *Tons.* |
| 1888 | 12 | 241 | 10 | 678 | 126 | 44,741 |
| 1889 | 14 | 241 | 10 | 678 | 158 | 46,319 |
| 1890 | 20 | 219 | 9 | 717 | 170 | 40,641 |
| 1891 | 20 | 220 | 10.5 | 717 | 120 | 44,536 |
| 1892 | 15 | 220 | 9.4 | 717 | 127 | 48,724 |
| 1893 | 26 | 220 | 9.4 | 717 | 158 | 44,927 |

TRANSPORTED.

| Year. | Cotton. | Wool and hides. | Lumber. | General merchandise. | Total weight. | Total value. | Total freight charges. |
|---|---|---|---|---|---|---|---|
| | *Tons.* | *Tons.* | *Tons.* | *Tons.* | *Tons.* | | |
| 1888 | | 2,925 | 2,324 | 9,867 | 15,166 | $737,432 | $83,541 |
| 1889 | 130 | 3,080 | 3,188 | 10,885 | 17,283 | 820,315 | 78,140 |
| 1890 | 80 | 4,153 | 2,938 | 14,844 | 22,015 | 1,069,189 | 129,132 |
| 1891 | | 3,218 | 2,434 | 15,992 | 21,644 | 1,061,082 | 160,215 |
| 1892 | | 3,092 | 1,865 | 12,538 | 17,495 | 846,946 | 165,852 |
| 1893 | | 2,469 | 2,243 | 12,711 | 17,423 | 811,289 | 159,723 |

## U 8.

## PRELIMINARY EXAMINATION OF BRAZOS RIVER, TEXAS, FROM ITS MOUTH TO THE TOWN OF RICHMOND.

[Printed in House Ex. Doc. No. 136, Fifty-second Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
*Washington, D. C., December 15, 1892.*

SIR: I have the honor to submit the accompanying copy of report dated December 7, 1892, by Maj. Charles J. Allen, Corps of Engineers, of the results of a preliminary examination of Brazos River, Texas, from its mouth to the town of Richmond, provided for by the river and harbor act approved July 13, 1892.

The improvement of the mouth of the Brazos River is in the hands of a corporation, the Brazos River Channel and Dock Company, with authority to extend its works of improvement as far into the mainland between the banks of the Brazos River as may be necessary to reach a place that will afford security from storms, swells, cyclones, and tidal waves.

Major Allen states that the river from Richmond downstream to the point to which the Brazos River Channel and Dock Company intends to extend its works should be classed as worthy of improvement by the General Government, provided the cost of improvement, to be determined by full survey, estimated to cost $2,500, be not out of proportion to the extent of commerce to be benefited.

The division engineer, Col. C. B. Comstock, Corps of Engineers, is of opinion that the river below Richmond is worthy of some degree of improvement by the United States, and in this opinion I concur.

Very respectfully your obedient servant,

THOS. LINCOLN CASEY,
*Brig. Gen., Chief of Engineers.*

HON. S. B. ELKINS,
*Secretary of War.*

## REPORT OF MAJ. CHARLES J. ALLEN, CORPS OF ENGINE

UNITED STATES ENGINEER OFFIC
*Galveston, Tex., December 7*

GENERAL: I have the honor to submit the following report liminary examination of the Brazos River, Texas, from its mou town of Richmond, a distance by river of about 102 miles, ma cordance with the requirements of section 7 of the river and ha of July 13, 1892.

A preliminary examination of the Brazos River from its m Waco, a distance of about 430 miles, was made in 1891, in com with sections 17 and 18 of the river and harbor act of 1890. port thereon is published in Ex. Doc. No. 63, House of Represen Fifty-second Congress, first session. In that report the opini expressed that the river from its mouth to Waco was not at pre garded as a stream that should be improved by the General G ment, and largely for the reason that an improvement would the construction of locks and dams for a long distance below Wa that the cost of improvement would be beyond all proportion to sulting benefit to commerce. The reports in that executive doc also refer to the fact that the improvement of the mouth of the r in the hands of a corporation authorized to charge and collect That corporation has authority to extend its work of improveme far into the mainland between the banks of the Brazos River as n necessary to reach a place that will afford security from storms, s cyclones, and tidal waves.

The same report also referred to the connection between the B River and West Galveston Bay by a canal owned and controlled private corporation, the Columbia Transportation Company, whic the right to collect tolls from vessels using it. The entrance t canal from Brazos River is about three-quarters of a mile abov original river mouth.

Produce seeking the Gulf of Mexico by water from Brazos Rive *vice versa* must therefore pass through channels controlled by pri corporations.

The principal shipping points below Richmond are: Velasco, 5 from mouth; Brazoria, 29 miles from mouth; Columbia, 37 miles mouth; Bolivar, 49 miles from mouth.

The Galveston, Harrisburg and San Antonio Railway crosses river at Richmond, connecting that place with Houston and Galves Buffalo Bayou, on which Houston stands, connects with the Gul Mexico through San Jacinto River and Galveston Bay.

The Gulf, Colorado and Santa Fé Railway crosses the Brazos point about 15 miles below Richmond, thence passes through Richmo connecting it with Galveston.

A branch of the International and Great Northern Railway conne Columbia and Houston and the same branch also connects with Vela through the Velasco Terminal Railway.

The bridge of the Galveston, Harrisburg and San Antonio Railw has a clear width of more than 200 feet between channel piers an at an elevation of about 45 feet above low water. The county brid which crosses a short distance above the railway bridge, has about same elevation and width between piers.

The bridge of the Gulf, Colorado and Santa Fé Railway, about miles below Richmond, has a width between channel piers of 248 fe and is at an elevation of about 48 feet above low water.

None of these bridges have drawspans.

There are no shoals reported between the mouth of the river and Columbia, but between the latter point and Richmond there are said to be a number of them. Snags, in greater or less numbers, however, are found between the mouth and Richmond.

There are three steamers navigating the river from Bolivar down, as against one so employed last year. These boats belong to the Columbia Transportation Company. The present annual traffic, as given by that company, is as follows:

| | | |
|---|---|---|
| Cotton | bales | 6,000 |
| Cotton seed | sacks | 30,000 |
| Sugar | hogsheads | 600 |
| Molasses | barrels | 1,200 |
| General merchandise and miscellaneous freight | tons | 5,000 |

The greater part of which passes through the canal mentioned.

The lands bordering Brazos River are exceedingly fertile and productive, but the farmers along the river, especially so above Bolivar, labor under the disadvantage of having to haul their products to railroad points separated by long distances on account of the precarious navigation of the river above Columbia, due to obstructions, largely snags, in the channel.

It is claimed that an improvement of the river below Richmond would be followed by an increase in number of steamers and barges navigating the stream, thus facilitating the shipment of the products of the country.

Taking all the facts into consideration, it appears that the producers of the valley of the Brazos River within the limits examined should have some relief in the shape of increased facility for water shipments, and I am therefore of opinion that the river, from Richmond downstream to the point to which the Brazos River Channel and Dock Company (the corporation mentioned as having been authorized to improve the mouth of the Brazos River) intends to extend its works inland, should be classed as worthy of improvement by the General Government, provided the cost of improvement, to be determined by full survey, be not out of proportion to the extent of commerce to be benefited thereby. A full survey will cost $2,500.

The preliminary examination required by the act of 1892 was made in October last by First Lieut. William C. Langfitt, Corps of Engineers. His report, which is complete and valuable, and to which attention is respectfully invited, is herewith. Many of the items in my own report are taken from it.

Very respectfully, your obedient servant,

CHAS. J. ALLEN,
*Major, Corps of Engineers.*

Brig. Gen. THOMAS L. CASEY,
*Chief of Engineers, U. S. A.*

(Through Col. C. B. Comstock, Corps of Engineers, Division Engineer, Southwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
SOUTHWEST DIVIS
*New York, December*

Respectfully forwarded to the Chief of Engineers.

I concur in Major Allen's opinion that the Brazos River b
mond is worthy of some degree of improvement by the Uni

C. B. COMSTOCK,
*Colonel of Engineers, Bvt. Brig. Gen., U. S.*
*Division*

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REPORT OF LIEUTENANT WILLIAM C. LANGFITT, CORPS OF ENGIN

UNITED STATES ENGINEER O
*Galveston, Tex., Novemb*

MAJOR: I have the honor to submit the following report on a prelimi
nation of the Brazos River from its mouth to the town of Richmond:

A survey of this river was made in 1874 from Waco to its mouth,
printed in the Annual Report of the Chief of Engineers for 1875, Part I,
made thereon.

In House Ex. Doc. No. 63, Fifty-second Congress, first session, is print
of a preliminary examination of this river from its mouth to Waco, a
river of 430 miles. The portion now under consideration is less than one
distance, and is that part of the river which is most susceptible of impro
which has the least rail facilities.

From the above reports and my personal visits to the river, the followi
tion of it is compiled and is sufficiently accurate for the purpose:

The distance from the mouth of the Brazos to the town of Richmond i
miles by the river. From the mouth to Brazoria, a distance of 29 miles,
considerable number of snags in the river which, under a large or night
would be dangerous, but which, by the present limited navigation,
avoided. From Brazoria to Richmond, a distance of about 73 miles, th
come more numerous and increasingly dangerous to navigation on acc
decreasing width of river.

There are no shoals between the mouth of the river and the town of C
distance of 37 miles, which would obstruct any ordinary river navigation.
Columbia and Richmond I am informed that there are such shoals, but of
ber and character no definite information could be obtained.

The banks of the river are high and easily eroded, nearly every convex
ing recent signs of the action of the current. They are also wooded and
parts furnish a new supply of drift and snags every high water.

Near its mouth the river is about 600 feet wide at low water; at Richn
same stage it is from 150 to 175 feet wide.

About 15 miles below this town the Gulf, Colorado and Santa Fe Rail
the river by a bridge having a clear width between channel piers of 248
height above low water of 48 feet. At low water the river is entirely bet
piers. At the town of Richmond the Galveston, Harrisburg and San An
way crosses the river, and a short distance above this bridge is a cou
Both of these bridges have a clear width between channel piers of over 2
are about 45 feet above low water. At low water the river is entirely b
piers. None of these bridges have draw spans.

It is claimed by some of the river men that the removal of the snags t
in the river between the mouth and Richmond would enable them to na
ordinary stages as far as the Gulf, Colorado and Santa Fe bridge mentio
This, however, is very doubtful, as no boat has ascended the river above
miles from the mouth) for many years.

The improvement of the bar at the mouth of the river is in the hands
corporation authorized to make that improvement. This corporation cla
over the river for a distance of 12 to 14 miles from its mouth and proposes
least two cut-offs in that distance. It has constructed jetties at the m
river for the improvement of the bar and has the right to collect tolls from
entering the river between them. It has purchased considerable lands o
of the river near the mouth and has laid out and started the town of Vel

5 miles above the mouth. Some wharves and shipping facilities have been constructed by it here with the object of making the town a large and flourishing seaport, but at this writing the town has, perhaps, not over 2,000 inhabitants, and no facilities, such as compresses, etc., for handling the cotton and other crops that are grown on the Brazos bottoms. Several ships have been loaded this season with cotton and oil cake and others will probably be loaded, but the cargoes all come from the compresses and mills of Houston, with which there is direct rail connection. The commerce of these ships or other vessels which may bring supplies for the work of the company or for the town of Velasco from outside points is, of course, not to be included in determining whether the river is worthy of improvement by the General Government at this time.

Improvement of the Brazos from Waco to the mouth was contemplated in the summer of 1890 by private enterprise, but beyond a "preliminary survey" of the river from Waco to Richmond, I have not been able to learn that they have done anything.

About 1858 a small canal was opened between the Brazos and West Galveston Bay, thus giving inland water communication with Galveston for small vessels. The owners of this canal have the right to charge tolls on vessels passing through it.

It is thus seen that all commerce entering the river, either from the Gulf or through the canal, is subject to toll.

The present commerce of the river is carried on by means of three stern-wheel river boats, two of small size, the other larger. One of these boats makes two round trips weekly between Galveston and Brazoria or Columbia; the second makes one round trip weekly between the same points; the third is used to collect freight between Columbia and Bolivar, and bring it down to Columbia, where it is taken by one of the other two boats.

The present annual traffic, as given by the Columbia Transportation Company, which owns all the boats just mentioned, is as follows: Cotton, 6,000 bales; cotton seed, 30,000 sacks; sugar, 600 hogsheads; molasses, 1,200 barrels; general merchandise and miscellaneous freight, 5,000 tons. A very small per cent of this last item consists of freight between Velasco and Galveston, the remainder being carried between other points on the river and Galveston. It all passes through the canal mentioned above, and which is owned by members of the transportation company.

It is stated by a member of this company that the traffic is increasing along this portion (from Bolivar down) of the river, principally for two reasons, of which the first one is the construction of better roads from the river west toward Matagorda County and the bridging of the streams that these roads cross. The second is that several of the large plantations near the river, which, when held as one holding, were not cultivated at all, or but slightly, have in the last year or two been divided up into small farms and sold to settlers, thus increasing the cultivated acreage. This process is expected to continue in the future, as is also the development of better roads. It is estimated by parties familiar with the circumstances that not 50 per cent of the lands that were cultivated prior to the late war are now cultivated, and it is these idle lands that are being bought in small farms by incoming settlers. In addition to these lands, there is a very large acreage of timbered land bordering the river which will in time be cleared for cultivation, and which will increase the traffic of the river both by the lumber trade that will develop and by the crops cultivated on the cleared land. A member of the transportation company informed me that his boats had carried out during the past year a considerable amount of cedar lumber and that contracts were in force for other large amounts.

The increase in traffic during the past year is evidenced by the fact that now three steamers are employed over the same stretch of river (from Bolivar down) where last year there was but one.

Above Bolivar the boats do not now ascend on account of the presence of snags in the river, which render it impassable. The commerce of the river above that point is therefore at present nothing. What commerce would develop were the river rendered navigable as far as Richmond is very hard to predict. There are many large plantations along this portion of the river which at present do all their business by rail, and I am informed that a large part of it is done with Galveston. From Richmond and other points in the same county there are shipped annually about 10,000 bales of cotton. It is claimed by the residents of the town that the freight, exclusive of cotton, in and out of Richmond approximates annually $2,000,000, and that a large part of this freight and of the cotton would seek the river were boats enabled to ascend to the town. Below the town are several large sugar plantations. On one of these there are produced annually about 5,000,000 pounds of sugar, and it has upon it a refinery with a daily output of 150,000 pounds. I am informed that it is the intention to double the capacity of the refinery in the near future. Most of the raw sugar for the refinery is brought from Cuba to New Orleans and from there by rail. There are also other refineries besides this one, but of smaller capacity. It is claimed by the owners that were the Brazos opened so that boats could ascend to their plantations they could obtain their raw sugar and other supplie cheaper rates of freight. The same development of small farms is al along this portion of the river as described above for the lower portion.

In any case it is expected by those interested that the existence of an will act as a regulator of railroad freights and make them lower. It is freight rates from points already reached by the river are from 30 to cheaper than they are where this condition does not exist.

Of the fertility of the lands adjoining the river there can be no ques noted among the most fertile in the State.

Most of the commerce is carried on during only a portion of the yea September to March; that is, during that portion of the year when the generally at its low-water stage, thus requiring a less amount of imp satisfy the needs of commerce.

From my knowledge of the river I regard a survey as necessary to ena mate to be made with any approach to correctness of the probable cost of improvement needed.

As stated above, both of the outlets of the river are in the hands of porations, and vessels passing through them are subject to toll. One o porations claims control over the river for 12 to 14 miles from its mouth. these circumstances it would be much better that this control of the low the right to collect toll of vessels passing through the canal already ment be extinguished before the General Government should enter on an ex provement of the river.

Appended are two letters giving information about the river and its co from which some of the data given above have been taken.

Very respectfully, your obedient servant,

WM. C. LANC
*First Lieutenant, Corps of*

Maj. CHAS. J. ALLEN,
*Corps of Engineers.*

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LETTER OF MR. P. E. PEARSON AND OTHERS.

RICHMOND, TEX., *Novemb*

DEAR SIR: In accordance with our promise to you while here a few d date hereof, we furnish you with as much information as is practicabl circumstances.

The average depth of water between Richmond and Bolivar is about tide. There are many places where the water at low tide is 10 and 12 f between the points named.

The obstructions consist of sand bars and snags. There are only about sand bars to be removed. The amount of snags and drift to be remove stated with any degree of accuracy; neither can we speak advisedly as t of the sand bars to be removed, but our best information is that they are magnitude or would entail any great expense in their removal.

As to the produce, etc., shipped from this point: There is annually sh 5,000 bales of cotton from Richmond. From points adjacent to Richm county) there is shipped about the same amount of cotton, which would here if we were provided with transportation by water.

Within the last eighteen months about 40,000 acres of our best prairi Richmond have been purchased and settled upon by small cotton-plante sult of opening up and cultivation of this vast body of land, together w tive settlements soon to be consummated, will within the next ten ye the cotton shipments from this point fourfold.

The three sugar farms and refinery near Richmond pay to the railroad charges the sum of about $30,000 per month. Of this amount Col. Ed. alone pays about $800 per day. He informed us Monday that the cap mill and refinery would soon be increased to such an extent that his fre would aggregate the sum of $1,600 per day. All of these farms are l near the Brazos River, not a great distance from the town of Richmond clearing out of the Brazos River the immense freight that now comes b plantations mentioned would come by water transportation through The amount of freight in and out from Richmond, exclusive of cotton, proximates $2,000,000.

The Brazos bottom and Oyster Creek lands from the Austin County li side of the river down to and below the town of Brazoria embrace as fi cane lands as exist in the world. The development of this vast rich territory has been and is retarded for the want of transportation facilities, which would be afforded by placing the river in navigable condition to the town of Richmond.

If there are any other points upon which you desire information we will gladly respond on request.

Yours, very respectfully,

P. E. PEARSON.
THOS. DYER.
J. H. P. DAVIS.
JNO. M. MOORE.
M. J. HICKY.
A. M. HOLMES.
J. D. BRYANT.
CLEM. BASSETT.

Lieut. WM. C. LANGFITT.

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### LETTER OF MR. BRANCH T. MASTERSON.

GALVESTON, TEX., *November 4, 1892.*

DEAR SIR: In response to your request to furnish such data as may be obtainable as to the present and prospective traffic on the Brazos River from Richmond to its mouth, I beg to say that the bulk of the freight from Bolivar down is carried by the steamers belonging to the Columbia Transportation Company, and from examination of the freight books and other reliable data a close approximation of the present annual traffic is 6,000 bales of cotton, 30,000 sacks of cotton seed, 600 hogsheads of sugar, 1,200 barrels of molasses, and 5,000 tons of general merchandise and miscellaneous freight.

As near as I can ascertain, there is now less than one-third of the open lands now in cultivation. These open lands comprised large sugar and cotton plantations which were cultivated many years, but were closed out shortly after the late war. These large tracts are being subdivided and sold, and the area in cultivation is increasing. When all these fields are again in cultivation a fair estimate of the traffic would be 20,000 bales of cotton, 90,000 sacks of cotton seed, 5,000 hogsheads of sugar, 12,000 barrels of molasses, and 10,000 tons of merchandise and miscellaneous freight. This estimate relates only to lands that were in cultivation in past years. As the total area that has been cultivated does not comprise one-fourth of the lands suitable for farming, the traffic will increase as farms are opened up.

These estimates do not include the Cunningham and Ellis sugar plantations or the State plantation, as these and others, from House's sugar plantation on Oyster Creek up to Cunningham's, ship by railroad, being too far from Bolivar, the present upper landing for steamboats, to avail themselves of water transportation, the snags on the Brazos River above Bolivar preventing the navigation to the points near the upper Oyster Creek plantations.

The county of Brazoria has within the past twelve months expended $50,000 in bridging streams and making and improving the county roads, thus enabling the farmers to get their products to the river. This has resulted even this year in an increase in water transportation, the farmers of Matagorda County hauling to the Brazos River to avail themselves of water transportation freight rates.

Very respectfully,

BRANCH T. MASTERSON.

Lieut. LANGFITT,
*Corps of Engineers.*

# APPENDIX V.

## IMPROVEMENT OF CERTAIN RIVERS AND WATERWAYS IN LOUISIANA, TEXAS, ARKANSAS, MISSISSIPPI, AND TENNESSEE, TRIBUTARY TO MISSISSIPPI RIVER; WATER GAUGES ON MISSISSIPPI RIVER AND ITS PRINCIPAL TRIBUTARIES.

## *REPORT OF CAPT. J. H. WILLARD, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1893, WITH OTHER DOCUMENTS RELATING TO THE WORKS.*

### IMPROVEMENTS.

1. Red River, Louisiana and Arkansas.
2. Red River above Fulton, Ark.
3. Ouachita and Black rivers, Arkansas and Louisiana.
4. Bayous D'Arbonne and Corney, Louisiana.
5. Bayou Bartholomew, Louisiana and Arkansas.
6. Bœuf River, Louisiana.
7. Tensas River and Bayou Maçon, Louisiana.
8. Big Black River, Mississippi.
9. Yazoo River, Mississippi.
10. Mouth of the Yazoo River, Mississippi.
11. Tchula Lake, Mississippi.
12. Tallahatchee River, Mississippi.
13. Steele and Washington bayous, Mississippi.
14. Big Sunflower River, Mississippi.
15. Big Hatchee River, Tennessee.
16. Forked Deer River, Tennessee.
17. Water gauges on Mississippi River and its principal tributaries.
18. Survey of Cypress Bayou and the lakes between Jefferson, Tex., and Shreveport, La.

### EXAMINATIONS.

19. Sulphur River, Texas.
20. Little River, Arkansas.
21. Ouachita River above Camden, Ark.
22. Cassity Bayou, Mississippi.
23. Coldwater River, Mississippi.

UNITED STATES ENGINEER OFFICE,
*Vicksburg, Miss., July 1, 1893.*

GENERAL: I have the honor to transmit herewith annual reports upon works of river improvement in my charge for the fiscal year ending June 30, 1893.

Very respectfully, your obedient servant,

J. H. WILLARD,
*Captain, Corps of Engineers.*

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## V 1.

## IMPROVEMENT OF RED RIVER, LOUISIANA AND ARKANSAS.

The Red River of the South has its source in the *Llano Estacado*, northern Texas, and flows in a general easterly direction, forming the boundary between Indian Territory and Texas. At Fulton, Ark., its course changes to a general southeasterly direction, and after crossing the State of Louisiana it enters the Mississippi River at Red River Landing. The entire length of the river is about 1,200 miles; the part included in the project under the head of improving Red River, Louisiana and Arkansas, extends from Fulton, Ark., to the head of Atchafalaya River, Louisiana, a distance of 507 miles.

The importance of keeping this great waterway open to n was recognized by the United States as early as 1828, and a tions aggregating $535,765.50 were made at intervals between 1852. Between 1841 and 1852 no appropriation was made for on the work, and a longer period elapsed between 1852 and ing which the results of former work were lost. Between 185 the heavy rates of freight and insurance and the effects of water caused by the great raft became so burdensome to the interest above that obstruction that a charter was obtained State of Louisiana for the removal of the main raft by a st pany. The assent of Congress having been given to the projec resolution of February 21, 1861, and the company authorize tolls for a period of thirty years (Stat. at Large, vol. 12, p. 250), was taken by the planters interested, and the company was commence work in the spring of 1861, but the war of the rebel out and nothing was done.

An examination and survey of Red River from the mouth above the raft in Louisiana were ordered by river and harb March 3, 1871, the reports upon which are contained in Rep of Engineers, 1872, pp. 568–573; and 1873, pp. 635–676. Th improvement was commenced in 1872. The original projec plated removing the raft above Shreveport, La., and closi Bayou Outlet, on the right bank, 19 miles below Shreveport, ual enlargement of which diverted a large quantity of water seriously affected navigation of the main river below. Sub this project was enlarged to include the removal of jams, snag leaning timber, etc.; opening and enlarging the channel th falls at Alexandria, La.; deepening the channel at shoal pl closing outlets and constructing and repairing levees to confin to the adopted channel; in order to improve and keep naviga from Fulton, Ark., to the head of the Atchafalaya; also to p banks at Alexandria and Shreveport from erosion by the cur river; and to make a thorough and comprehensive survey fr to the Atchafalaya, with a view to the permanent improvem river.

The appropriations for the early work, from 1828 to 185 follows:

| Date of act. | General object of appropriation. |
|---|---|
| May 23, 1828 | Improving navigation of Red River through or around the raft in Louisiana and Arkansas |
| Mar. 2, 1831 | Arrearage due Maj. Burch for survey of raft of Red River, Louisiana |
| July 3, 1832 | Improving navigation of Red River, Louisiana and Arkansas, being ba ance of appropriation of 1828 carried to surplus fund, and the furth sum of $20,000 |
| June 28, 1834 | Improving navigation of Red River |
| Mar. 3, 1835 | Completing removal of obstructions to navigation of Red River |
| July 2, 1836 | Continuing the removal of obstructions in Red River |
|  | Constructing a boat to prevent a new accumulation of obstructions in R River within the old limits of the great raft, $15,000, and to work a support same, $15,000 |
| Mar. 3, 1837 | Continuing the removal of obstructions in Red River |
| Apr. 20, 1838 | The complete removal of the great raft in Red River |
| Mar. 3, 1841 | Removing the raft of Red River |
| Mar. 2, 1847 | Deficiency of appropriation by act of April 20, 1838, being amount advanc by Daniel T. Witlee and others through the branch of the Real Esta Bank of Washington, Ark., to Henry M. Shreve, Government agent, f removal of great raft, and expended by him for that purpose |
| Aug. 30, 1852 | Removing the raft of Red River |
|  | Aggregate of appropriations, 1828-'52 |
|  | Amount expended |
|  | Amount carried to surplus fund |

The appropriations for the improvement, commenced in 1872, have been as follows:

| Date of act. | General object of appropriation. | Amount. |
|---|---|---|
| June 10, 1872 | Improvement of Tones Bayou, Louisiana | $20,000 |
| | Removing the raft in Red River, Louisiana | 150,000 |
| Mar. 3, 1873 | do | 80,000 |
| June 23, 1874 | do | 50,000 |
| Mar. 3, 1875 | do | 20,000 |
| Aug. 14, 1876 | Removing the raft in Red River and closing Tones Bayou | 35,000 |
| Apr. 10, 1869 | Allotment made August 27, 1877, for closing Tones Bayou | 4,500 |
| Feb. 7, 1878 | Opening navigation of Red River above Shreveport, La., and keeping same open and free from rafts, and for purpose of preserving vessels of United States employed in that work | 6,000 |
| June 18, 1878 | Removing raft in Red River and closing Tones Bayou | 24,000 |
| | Removing snags and other obstructions from Red River | 25,000 |
| Mar. 3, 1879 | Removing raft in Red River and closing Tones Bayou | 15,000 |
| | Removing obstructions from Red River | 22,500 |
| | Improving Upper Red River, Arkansas, from Fulton to head of the raft | 10,000 |
| June 14, 1880 | Removing raft in Red River and closing Tones Bayou | 25,000 |
| | Removing obstructions from Red River, Louisiana, including construction of snag boat | 60,000 |
| | Improving Upper Red River, Arkansas, from Fulton to head of the raft | 10,000 |
| Mar. 3, 1881 | Removing raft in Red River and closing Tones Bayou | 10,000 |
| | Removing obstructions from Red River, Louisiana | 10,000 |
| Aug. 2, 1882 | Continuing improvement from the Atchafalaya to Fulton, Ark., including Bayou Pierre, Tones Bayou, and to relieve the town of Alexandria from encroachments of the river | 75,000 |
| July 5, 1884 | Continuing improvement from the Atchafalaya to Fulton, Ark.; not exceeding $15,000 for revetment to protect the harbor at Alexandria from damage by the current of river; not exceeding $5,000 to close the outlet known as Sale and Murphy Canal; the remainder to be applied to improvement of the main channel of the river | 75,000 |
| Aug. 5, 1886 | Continuing improvement from Fulton, Ark., to the Atchafalaya River, Louisiana, including completing the work at Alexandria, $25,000, or so much thereof as necessary, to be used in making a thorough survey of the river from Fulton to the Atchafalaya, and in completing survey of Bayou Pierre, Louisiana | 75,000 |
| Aug. 11, 1888 | Continuing improvement from Fulton, Ark., to the Atchafalaya River, including completing the work at Alexandria, $5,000, or so much thereof as necessary, to be used upon Cypress Bayou and the lakes between Shreveport, La., and Jefferson, Tex., and $5,000, or so much thereof as necessary, upon Bayou Dorcheat | 65,000 |
| | Completion of survey from Fulton, Ark., to the Atchafalaya River | 35,000 |
| Sept. 19, 1890 | Continuing improvement from Fulton, Ark., to the Atchafalaya River, $15,000, to be used in the work at Alexandria; $20,000 to be used in deepening and widening that portion known as Little River, from the Scopini Cut-off to Knox Point, and $5,000 in closing the Sale and Murphy outlet | 100,000 |
| | Completion of survey from Fulton, Ark., to the Atchafalaya River | 28,000 |
| July 13, 1892 | Continuing improvement from Fulton, Ark., to the Atchafalaya River, according to plan of Capt. J. H. Willard, Corps of Engineers, and for completion of survey; including the work at Alexandria, the widening of that portion known as Little River, the necessary work at the harbor at Shreveport, the closing of outlets on the west bank of the river above Shreveport, and the removal of the tow-head just above Rush Point, Caddo Parish (of which $5,000 may be used, in the discretion of the Secretary of War, for work in Cypress Bayou and the lakes between Shreveport, La., and Jefferson, Tex.) | 145,000 |
| | Aggregate of appropriations, 1872 to 1893 | 1,175,000 |

The amount expended to June 30, 1892, under the project of 1872, was $987,413.99 (including outstanding liabilities of $107.12), resulting in great benefit to navigation. In 1872 the upper river was closed by the great raft, extending from Carolina Bluffs, 33 miles above Shreveport, La., upstream 32 miles, to within 4 miles of the Louisiana and Arkansas State line, and added to by each flood. A channel was opened through this obstruction in 1873, and operations since, aided by the action of the current, have secured greater width and depth throughout the entire reach, with a channel way constantly widening and scouring, until at the present time but little water is diverted from the river proper except at flood stages. Moderate estimates, made in 1872, showed that the removal of this obstruction alone resulted in a saving of $150,000 annually to the planting interests

above the raft, besides relieving, to a great extent, not less tl
acres of productive lands from overflow. (Report Chief of E
1873, p. 665.) The work of removing obstructions from the
clearing the banks, and the prompt breaking of all jams an
the drift in motion during high stages of water have prevente
of the raft. Several attempts were made to close Tones Bayc
work has been done at that outlet since 1882, when the d
construction was destroyed. The bayou is filling up gradu
drift, and this, in connection with the work in the old raft
causing the "Little River" (below the mouth of Tones Bayou)
and scour, the effect having been particularly noticeable withi
four years. The rock excavation and dam at the Falls of Al
were completed in 1885, increasing the period of navigation a
months, and as a general thing permitting boats to pass the
year round, though passage was somewhat difficult at extr
stages on account of the deflection at the middle of the cut.
and training wall for protecting the bank at Alexandria, built in
accomplished the purpose for which intended, and it is plain
banks no longer cave within their influence. The removal o
logs, and wrecks from the channel and clearing the banks for
eral improvement of the river were not begun until 1878, al
appropriations having been for the removal of the raft and
Tones Bayou; but since 1885 operations have consisted chiefly
class of work. In March, 1887, circular letters were sent to
interested in navigation of Red River, asking information re
wrecks, their location, amount of obstruction, etc. Five lists
ceived, giving names of boats, partial causes of loss, and sp
those that were serious obstructions. Upon comparison it wa
that in fifty years 197 steamboats had been lost in Red Rive
average of about 4 a year; one list gave 86 snagged, 21 bur
destroyed during war, 4 exploded, and 3 destroyed by collision
tention is invited to the foregoing as evidence of the fact that
tion is becoming better and safer every year, for during the las
years steamboats made regular trips at lower stages than ever
before, without detention and with but one serious accident. Tl
and Murphy outlet, at the head of the old raft, was closed
heavy earthen dam, completed in November, 1891, which resist
unprecedented flood of May, 1892, without sustaining serious d
and has caused the channel of the river through the old raft reg
scour rapidly.

The removal of snags and other obstructions should be contin
many years. In the old raft region above and below Shreveport, s
logs and stumps are scouring loose continually, and are a constant
of danger to low-water navigation. Others, thoroughly water-l
form bars, impassable at low stages. The banks of the upper riv
hundreds of miles, are covered with a heavy growth of timber,
is caving and sliding into the river continually, and during high
the amount of drift is enormous. In the raft region above Shrev
jams form in a few hours, often acres in extent, and require p
removal before the water falls. Caving banks leave dangerous
snags projecting far out into the river, which should be cut after
rise and fall.

As stated heretofore, whatever plan may be adopted for the p
nent improvement of Red River, or even if the work of givin
assured reasonable navigation to Shreveport and beyond be delay
a time, there are certain general principles to be followed, if on

save till that time comes what has been gained, or to prevent the river closing. These principles are stated in natural sequence, as follows:

1. The systematic clearing of the banks for some distance back, far beyond the limits of this district. It is cheaper to remove the source of drift than to dispose of the drift itself; and the benefit to navigation is immediate.

2. An efficient snag boat service for general work, patrolling the river, preventing jams, removing snags and logs from the channel and banks, and dredging tow-heads and obstinate shoals. Here, again, the benefit is immediate. A permanent appropriation of not less than $25,000 a year is needed for this purpose.

3. Extending the scope of the survey to embrace the whole valley. This is necessary to the proper study of this river and tributaries, and to furnish all the information required to decide upon a system of improvement and to locate its elements.

4. Construction of a substantial system of levees to restrain the greatest floods, either alone or in conjunction with the riparian States.

5. Closing gradually every outlet through which the main stream is depleted at various stages above low water.

6. Fixing caving banks to confine the main stream to the channel selected for it. Ordinarily fixing caving banks should precede levee building and closing outlets, but as the banks are reasonably stable for a considerable part of Red River, and as the object is to get improved navigation without unnecessary delay, revetment is placed after them.

7. To exercise a watchful care from first to last to prevent injury to the regimen of the river by cut-offs or outlets, and to keep the building of bridges within reasonable bounds.

During the fiscal year ending June 30, 1893, operations were continued as follows:

## GENERAL IMPROVEMENT.

During July and August, 1892, preparations were made at Shreveport, La., for getting all the boats ready for service during the low-water season, and the necessary minor repairs were made for that purpose.

It having been decided that the extensive repairs of the iron bottom of the United States snag boat *C. W. Howell* could be deferred until after the season's work, that vessel was fitted out first, and in command of M. B. Lydon, master, left Shreveport August 13 for work in the river above, was employed in putting the stretch between Shreveport and Cowhide Bayou, 34 miles, in good navigable condition, and returned to Shreveport August 18.

Accompanied by Assistant Engineer H. M. Marshall and Assistant State Engineer of Louisiana F. M. Kerr, I made an inspection of the river above Shreveport to the Arkansas line on the *Howell*, August 21–23. On the way back the iron balance rudder struck a hidden obstruction and was broken off, but a temporary wooden rudder was made and shipped at Shreveport August 24, and August 25, 26 the inspection was continued down to White Hall Landing, 44 miles below Shreveport, for the purpose of examining the stretch known as the Little River below Tones Bayou.

After returning to Shreveport August 26, the crew of the *Howell* assisted in getting the snag boats *Wagner* and *Breck* and the dredge *Lone Star* ready for work, and on the 27th the hand-propelled snag boat *Breck* was towed to the cut-off above Shreveport. August 27–30 the

dredge was towed from Shreveport to Le Compte Bar, about
below, after which the *Howell* continued down the river to th
boats at Barbre Landing, near the mouth. September 1–8 tl
was employed in towing the quarter boat designated for use
of Yazoo River to Vicksburg and in returning to Red River.
ber 9 the remaining quarter boat was taken in tow and was
at Alexandria, La., September 11, for use on the work at that

September 12 the *Howell* left Alexandria for work in R
above, and the following day met the dredge *Lone Star* on th
work at the Upper Falls. The dredge was towed to Alexan
tember 15, and the snag boat remained at that place until Se
20, assisting in starting the work. On the latter date it
snagging operations in the river above, and effective work
at the lowest stages of water to Grand Bayou, about 50 mil
Shreveport. October 3 a crack was observed in one ot the boi
the boat kept at work under low pressure until October 9,
hope of being able to clear the low-water channel to Shrevepor
a rise set in. On Sunday, October 9, an inspection of the bo
made, and the master decided it would be unsafe to continue w
the boat ran to Shreveport for repairs. The repairs of the boi
putting on a new iron balance rudder, to replace the temporary
rudder shipped in August, were commenced October 10 and co
October 14. October 14–22 the boat was employed on the st
river between Mercer Landing and Shreveport, which was ba
structed at low stages. October 24 the agent of the Red Riv
at Shreveport reported the upper river in bad condition, especia
part near where the steamer *Friendly* sank October 8. The
left at once for above, and was employed between Shreveport an
Point, a distance of 34 miles, until October 28. During this pe
rise of the river prevented much work for improving the low
channel above Shady Grove, 12 miles above Shreveport, where
tions consisted of the removal of jams and drift. October 29–
boat received supplies and made minor repairs at Shreveport, a
following day left for the lower river, ran to Lake Long, about 12
above mouth of Black River, where it commenced working ups
November 5, reached Alexandria November 9, where it was em
until November 15 in towing barges, etc.

November 15–19 the boat returned to Shreveport, having be
tained on the way by a leaking boiler. The division enginee
expected about that time to make an inspection of the river
*Howell*, but as he was delayed by sickness, the boat was emp
above Shreveport until November 24. November 28–29, Col.
stock, Division Engineer, Assistant Engineers Marshall and Ewen
myself made an inspection of the river on the *Howell* from Shrev
to the upper end of the Blanton Bluff and Bargetown Levee, nea
Arkansas and Louisiana line. On the way back the boat str
hidden obstruction, which knocked a hole in the iron bottom o
vessel. Col. Comstock left for Capt. Taber's district the morni
the 30th, and on that date I continued the inspection down to Ha
Levee, after which the *Howell* returned to Shreveport for repairs.
work of patching the hole in the bottom of the boat was finishe
cember 6, after which I made an inspection of the river between Sh
port and Alexandria, reaching the latter place December 8.

The *Howell* commenced working back December 10, and arriv
Shreveport December 17. All obstructions in sight were remove

the way, including 2 large drift piles at Golconda Bend and wreck of steamer *Falls City*. December 17, on the way up, the snag boat *Breck* was towed by the *Howell* from Sunflower Landing to Shreveport, 10 miles. From December 18 to 25 the *Howell* remained at Shreveport, undergoing repairs of boilers and machinery and riveting the patch upon the bottom, which had been bolted temporarily. December 26–31, the boat was employed in the upper river, between Shreveport, La., and Fulton, Ark., and removed all obstructions in sight. The master found that 2 cut-offs had been made during the year, at Ferguson and Crowell, Ark., 14¾ and 63½ miles below Fulton, respectively.

After reaching Fulton, the *Howell* was transferred temporarily to the work of improving Red River above Fulton, Ark., after suspension of which it returned to Shreveport, March 14, 1893.

March 16, the *Howell* left for Alexandria, La., with the hand propelled snag boat *Breck* in tow, in order that the entire plant in Red River should be consolidated at the latter place, to reduce the expense of care of property, and to have the *Breck* convenient to the work below Alexandria when the water should fall sufficiently to resume shore work. The boats reached Alexandria March 18, and the *Howell* remained at that place until April 13, when it left to work in the river above. On this trip special attention was given to wrack heaps and tow-heads that could not be removed with the snag boat at low stages, and to blasting off hard clay points that caused the opposite banks to cave. Work was carried from Alexandria to Fulton by May 5, and all obstructions in sight and what could be reached with the drag chain were removed. May 6–7, the *Howell* returned to Shreveport, where the crew was dischared with exception of employés required to make needed repairs.

Accompanied by Hon. N. C. Blanchard, member of Congress for the district and late chairman of the River and Harbor Committee, Chief State Engineer of Louisiana H. B. Richardson, and Assistant State Engineer F. M. Kerr, I made a trip of inspection on the *Howell*, May 27-29, over the 157 miles of river between the Arkansas State line and Knox Point, Louisiana, visiting all important levee work, completed or in course of construction, on the way. After returning to Shreveport May 29, the boat was laid up, as the water was too high to work to advantage.

The following is a summary of the work done during the year by the snag boat *Howell* for improving Red River between Fulton, Ark., and the head of Atchafalaya River, Louisiana:

| | |
|---|---|
| Snags pulled | 732 |
| Stumps pulled | 77 |
| Logs removed from channel | 2,869 |
| Piles removed from channel at Shreveport Bridge | 17 |
| Shore snags cut | 104 |
| Leaning trees cut | 98 |
| Jams removed | 6 |
| Side jams removed | 27 |
| Hard-clay points removed with explosives | 5 |

Wrecks removed, viz: Steamboat wheel and shaft taken from channel between Hurricane Bluff and Moultrie; wheel and shaft of steamer *Friendly*, sunk October 8, 1892, near Douglas Place, La., and wreck shifted out of channel and to a position parallel with the current to stop caving banks.

The United States snag boat *O. G. Wagner*, A. P. Boardman, master, was fitted out at Shreveport, La., in August, 1892, for work in Ouachita and Black rivers, left Shreveport August 30, and between that date and September 14 removed the following obstructions from Red River between Shreveport and mouth of Black River, viz:

| | |
|---|---|
| Snags pulled | 69 |
| Stumps pulled | 5 |
| Logs removed from channel | 266 |
| Shore snags cut | 52 |
| Leaning trees cut | 13 |

The United States dredge *Lone Star*, W. G. Phillips, engineer, in charge, while in tow of the snag boat *Howell*, en route to Alexandria, was dropped at head of Le Compte Bar, August 30, as there was not sufficient depth of water for the dredge to pass that obstruction. A brush wing dam was commenced at once and completed September 5, enabling the dredge to continue downstream. The dam was 227 feet in length and gave immediate benefit to low-water navigation across the bar. September 5–13 the dredge floated downstream, with delays on account of high winds, draft of water, etc., until the snag boat *Howell* was met the latter date, when it was towed to Alexandria.

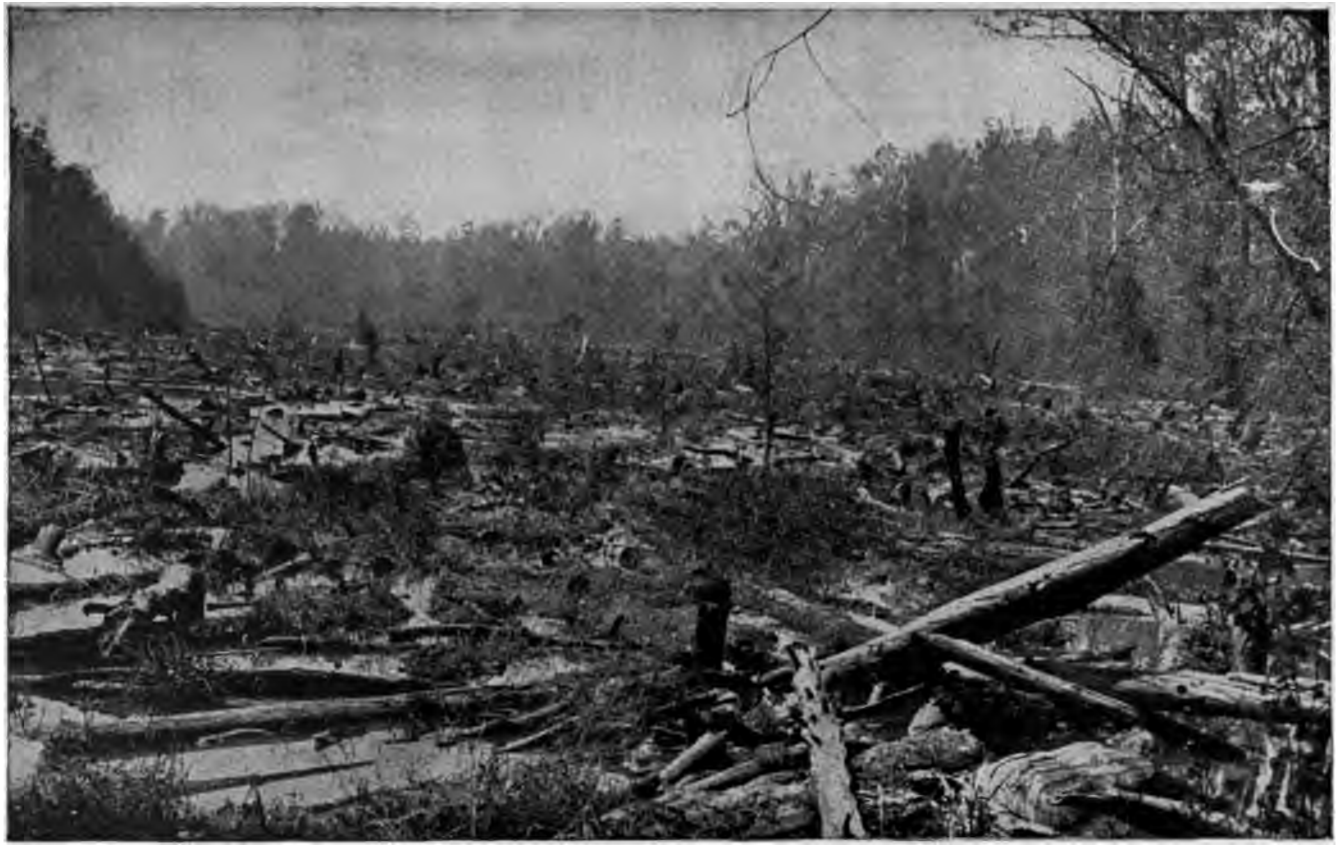
The hand-propelled snag boat *Harry Breck*, Robert Elflein, overseer, in charge, commenced work at the cut-off near Herndon Landing, 1¼ miles above Shreveport, August 27, 1892, which was carried upstream to Gilmer, La., a distance of 44 miles. Operations with this boat consisted of clearing both banks and removing shore snags, stumps, etc. August 27 to September 14 the river was at a low stage, and from Herndon Landing to Buck Hall, 13½ miles, efficient work was done, but few shore snags or stumps remaining under water. September 15–18 there was a temporary rise of about 4 feet, which covered some of the obstructions, but during the remainder of the time, until October 21, the river was at a low stage. On the latter date the river commenced rising, and by October 28 had risen 11 feet. Finding that work could not be continued above Gilmer with advantage the boat turned back October 28 and reached Shreveport the following day. During November the *Breck* was employed in the "Little River" between Scopini Cut-off and Knox Point, and report of the work done is given under that head. December 1–7, 1892, the boat continued work between the mouth of Bayou La Chute and Star Point, La., about 5 miles, after which it was laid up to await a low stage of water.

The following is a summary of the work done by the snag boat *Breck*, August 27–October 31 and December 1–7, 1892:

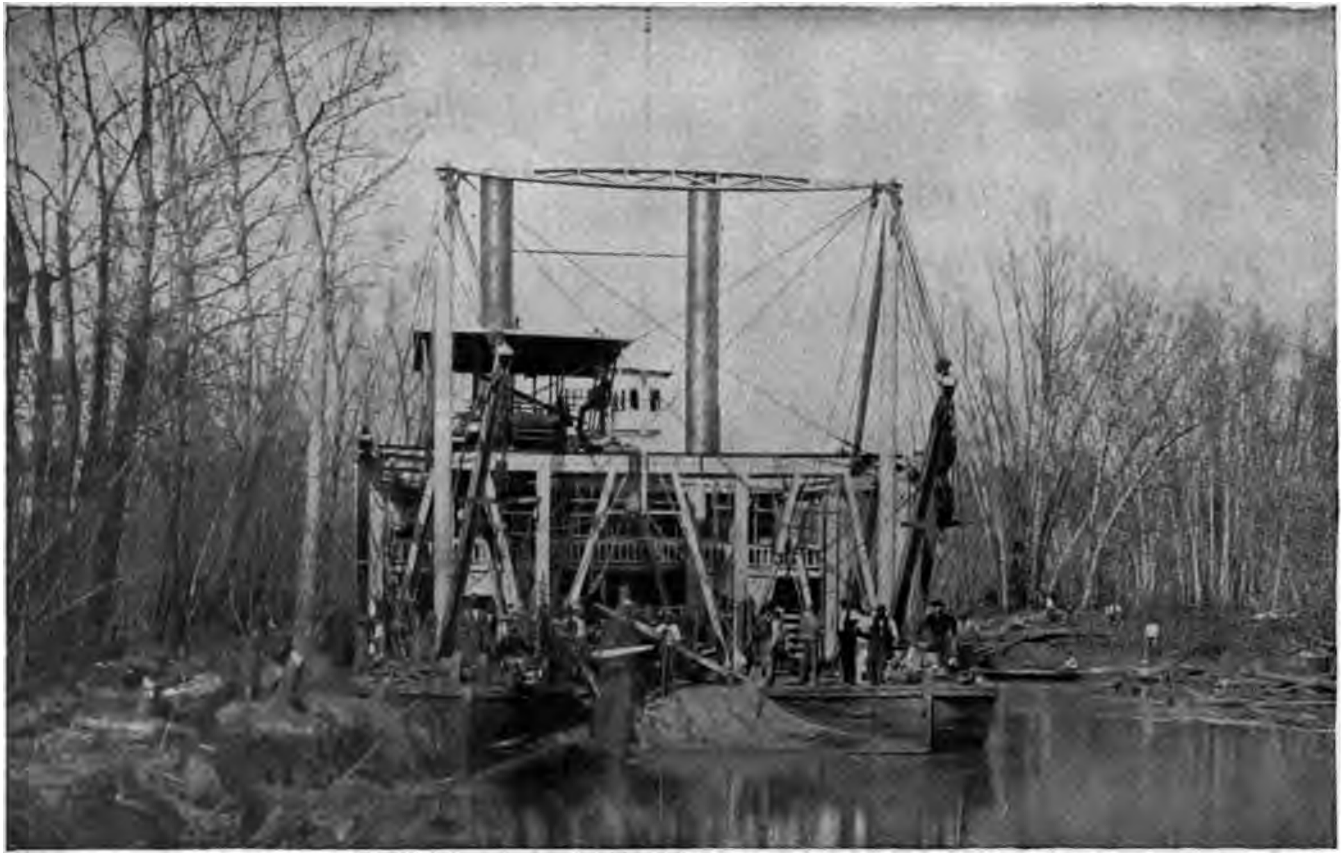
| | |
|---|---|
| Shore snags removed | 9,738 |
| Stumps removed | 1,177 |
| Side jams removed | 1 |
| Hard-clay points removed with explosives | 1 |
| Leaning trees cut | 769 |
| Trees girdled | 24 |
| Square yards brush and willows cut | 8,150 |

The work of the snag boats during the year has been of great benefit to navigation. The river from Fulton, Ark., to mouth of Black River, La., was worked over thoroughly twice, and the most obstructed portions were worked over after every rise and fall, reducing the risks to a minimum, and enabling steamboats to make regular trips without hindrance.

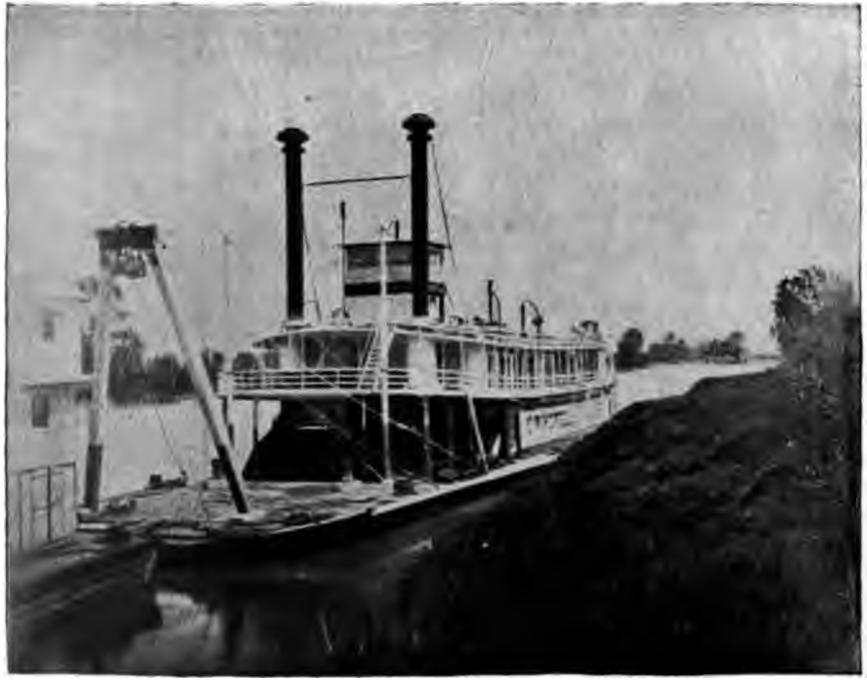
Only one wreck was reported during the year, that of the steamer *Friendly*, a vessel of 66.76 tons, 120 feet long, 26.6 feet beam, and 3.3 feet deep, built in 1888, which sank near Douglas Place, 20 miles above Shreveport, La., October 8, 1892, on the return trip from Gilmer, at the lowest stage of the year (gauge-reading 1 foot at Shreveport). It was



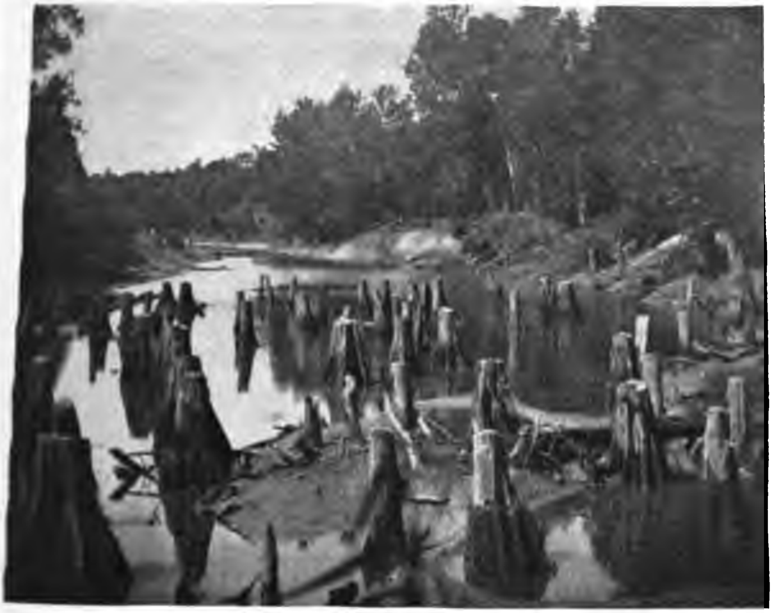
View of Red River Raft. High Water, 1872.



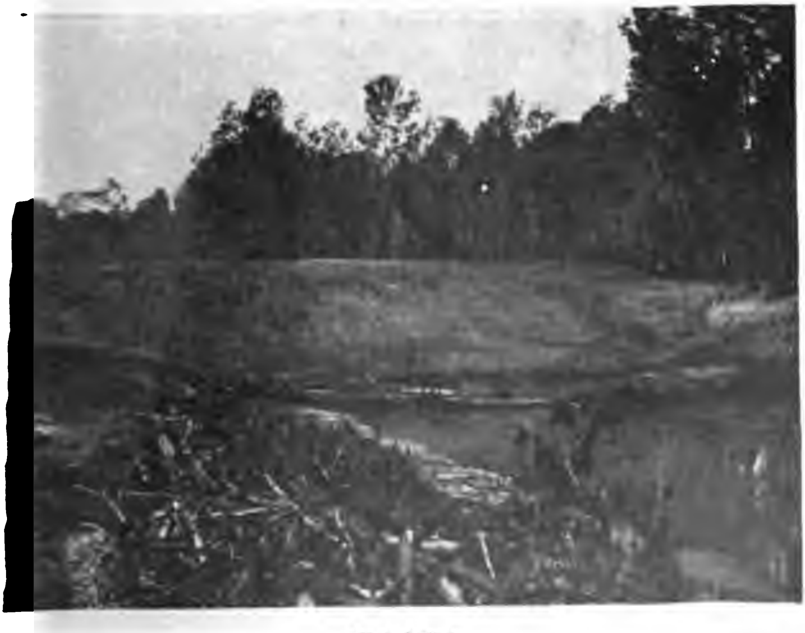
REMOVING RED RIVER RAFT, 1872. U. S. STEAMER "AID."



U. S. Snag Service, Red River, Louisiana and Arkansas. U. S. Steamer "C. W. Howell."



Before closing.



After closing.

SALE AND MURPHY OUTLET, CLOSED NOVEMBER 27, 1891.

reported that the boat struck a sunken log October 7 on the way upstream, but pulled over it with lines, and on the return next day struck the same obstruction, and in attempting to drive across it with steam power broke a hole through the bottom and sank immediately. The boat was owned in Jefferson, Tex., and was under charter to the Red River Line. The wreck caused the bank to cave, endangering the new levee, and was shifted out of the channel and to a position parallel with the current by the snag boat *Howell*, November 23–24, 1892, and will be destroyed when the water falls to a low stage.

The amount of improvement that has been accomplished by patient work with moderate and intermittent appropriations best can be judged by comparing present conditions with those that existed before the Great Raft was destroyed. An account of business and social conditions of forty years ago, lately published in the Shreveport Times, contained a statement by an old citizen of the parish that he crossed Red River in the autumn of 1855, just above Cross Bayou, on a fence rail touching shore and shore. Red River at that point is now 400 feet wide, with a maximum depth of 13 feet at ordinary low water, or zero of Shreveport gauge. It should be mentioned that 1855 was a noted low-water year for Mississippi River and its tributaries, and that no rain fell in Upper Red River Valley between May and October. Shreveport then was the head of navigation at ordinary stages, the river being filled with drift and growing timber for more than 50 miles above Cross Bayou, often above high-water mark. The river above the raft was reached by devious routes, through lakes and overflowed lands on either side, and "canals" dug by private parties, who exacted heavy tolls under State charters. But even these "channels" were not navigable except at stages considerably above low water.

Looking at photographs of the raft before and during operations, one would say that it had been easier to cut through rock than to make a navigable river through such a mass of tangle, that grew higher and larger with every flood, yet to-day there flows in the channel marked out for it a broad and deep river, safe at all stages, except for an occasional snag that drifts from above or a log that rises from the bottom as it scours. Since the removal of the raft intermittent work by the snag boats has produced better results by assisting the river to do its work than perhaps could have been effected by continuous application. At any rate the method has been the most economical, allowing wider range for operations and producing a more uniform deepening throughout the whole of the obstructed river.

I submit photographs of part of the raft in high water, and of the snag boat *Aid*, taken in 1872; kodak pictures of the steamer *Howell;* and views of the Sale and Murphy "Canal" or outlet, and of the dam built in 1891 to close it. The last picture was taken during the low-water season, and gives some notion of the fall of low-water surface since the raft was removed, for when the "canal" was used the navigable channel was over the tops of the cypress stumps shown in the foreground. The main channel of Red River at the Dawn Stumps, about 12 miles above Shreveport, was obstructed in the same way until quite recently, the stumps being cut off from time to time without apparent relief to navigation, until finally they were all blown out. It was in working over this part of the river that attention first was called to the drop in the low-water line, but no idea could be had of the amount, except from the report that the stumps had been cut off several times. Having recovered some of the benches of Maj. Howell's and Lieut. Woodruff's surveys, and reducing the levels to the Cairo datum, it is found that the low-water line has fallen more than 15 feet at the head of the raft, diminishing to about 3 feet at Shreveport, while a similar reduction has been going on in the river below. These facts are shown on the hydrograph with the report on Cypress Bayou. Plotting the soundings for sections and channel depths to the same scale as those of the new survey, we find a marked deepening of many feet throughout the whole distance.

This improvement will continue, not only because the same forces are at work, but because by the coöperation of the United States Engineers, the State engineers of Louisiana, and the levee boards, outlets gradually have been closed, and a levee system begun and extended, so that eventually the main river shall carry its waters without dispersion and without danger to the people of the valley. If no cut-offs are allowed, and if the banks can be held after the proper sections shall have been attained, I am confident that the limits of high and low water will be lowered to such an extent as hardly to require levees for the greatest floods, while the river will afford open navigation the year round to all boats that can enter from Mississippi River. In my opinion, there is nothing difficult in this improvement save in finding an economical method of fixing the banks. Building levees, dams, and the like, or removing shoals by artificial or by natural means, are easy and need little study except where and how much. But to make a permanent bank at reasonable cost, with a low average percentage for maintenance, that shall resist abrasion of the river at all stages, and shocks from drift, and especially from boats, for in streams like Red River wharves are not to be thought of, is the serious problem to work out.

Large sums have been spent in experiments upon many of our rivers, on some of which knee-deep navigation is hoped for, and it would seem worth while to work in that direction on Red River, if only to learn what not to do. So far as navigation is concerned, a large part of Red River is deep enough, and this can be maintained if the regimen is not impaired. The levee engineers, who build only to protect the people from flood, say "give us stable conditions and we will build nearer the bank," and if this were done the levees would play their full part in the work of improving navigation; but thus far the various forms of bank protection have had small measure of success. It is suggested that experiment be turned rather to holding the foot of the bank than to overloading a steep slope with short-lived mattresses and expensive stone, and to see if the natural banks will not stand, as *they do now where not under-scoured.* In some cases dikes or spurs might be needed to prevent too near approach of channel line or flanking, but it is probable that little stone would be needed except as riprap at the foot of the slope. It is desired to experiment with water-tight sheet-piling at Alexandria and Shreveport in the direction suggested in the foregoing remarks.

The plant for this part of the district is in good condition, considering its age, with the exception of the snag boat *Howell*, which should have a new steel bottom soon. As such work will have to be done at St. Louis, Louisville, or New Orleans, it is probable that the cost will not be less than for similar work on the *Wagner* and *Meigs*, and therefore the same amount, $10,000, is estimated for this purpose.

It is not desirable to increase the plant to such an extent as to require a large force to care for it when laid up, but a few additions should be made for use on work that can not well be done by contract, or that requires prompt attention. A large dredge for filling in and for quick work on channel shoals and tow-heads is very much needed, and the kind that would be most effective is of the "Hercules" pattern, with traveler or spout to deposit the material at a distance of 50 feet or more from the cut. A dredge of this kind would cost very nearly $30,000, delivered at Shreveport, as probably the hull would have to be built on Ohio River, and the cost of towing up Red River would be great. A steam-hammer pile-driver is also required, which will cost $4,000, and a small fast steamboat for general service, inspection, current measures, and towing, for which $16,000 is estimated. A quarter-boat and four barges complete the list of additions, at a cost of $10,000. It is most convenient to purchase plant from one appropriation, and to charge each allotment a reasonable amount for use and for the repairs while in service. By this method a small plant may be used advantageously upon the different streams as required, and kept in good working order without being a heavy charge upon any one of the appropriations.

Experience has proved the wisdom of allotting a considerable sum for the snag boat service, to prevent jams, which, if neglected, in a short time might become formidable and endanger both the river and the levee system, and the prevention of snags by removing the source in cutting leaning trees and clearing the banks as far upstream as the funds will allow, needs no further argument in its favor. The estimates for service of plant, repairs, and care when laid up, or when appropriations fail, are from necessity for two years, although the amounts could be spent profitably in one year by carrying on the work on a more extensive scale. The gauge service should be extended, and a small amount allotted for leveling and monuments, in order to get fuller information of the advance of the general improvement and for reference in future work.

## LITTLE RIVER FROM THE SCOPINI CUTOFF TO KNOX POINT.

The approved project for work in this stretch of river, 17½ miles long, given in my last annual report (pp. 1587, 1588, Report Chief of Engineers, 1892), contemplated sending snag boats over the stretch at short intervals during low water; and dredging at points where the bottom was of resisting clay, beginning where the bottom line showed highest and continuing as long as found desirable.

August 25, 26, 1892, this part of the river was inspected by Assistant Engineer Marshall and myself. The Shreveport gauge stood about 1.5 feet above zero, but the river from Scopini Cutoff to Knox Point generally was found so deep as to make it necessary to use a lead line for sounding, instead of the usual 10-foot pole. There was no way of determining where the "deepening" required by the act of 1890 should be made, except by sending a boat down the river, noting the movement of shoals and formation of new ones, if any, and taking a sufficient number of sections to cover them. As to "widening," the problem soon will arise how to stop it to prevent Red River cutting into Bayou Pierre.

The State levees stood the greatest flood of record (1892) fairly well, and as a rule yielded only where the banks caved under them. It was not considered advisable to do any dredging unless hard shoals should develop; the only work needed being the intermittent dragging of the sweep chain by snag boats in going up and down the river, with occasional help above and below the Scopini Cutoff to hasten the closing of Old River, but no dams should be built across Tones Bayou at present. I found both branches of the Old River closed by sand bars, the upper end about 2 feet and the lower about 6 feet or more above the water surface, and it was believed that the natural closing of the outlet will be safest, unless there should be enough money available to revet the banks for a mile above and for several miles below.

On my return to Vicksburg I reported this information to the Department August 30, with the recommendation that the portion of the project calling for dredging be modified or suspended as found necessary, and that an examination of the stretch be made, at an estimated cost of $1,000, which recommendations were approved September, 5, 1892.

With the exception of the work of the snag boats *Howell* and *Wagner* while passing through "Little River," nothing was done during the fiscal year beyond the operations of the hand-propelled snag boat *Harry Breck* in November, 1892, which consisted of clearing caving banks, cutting and blasting stumps that had slid into the stream, and removing shore snags. The caving banks were cleared for a distance of 30 feet back from the river, and the trees and logs cut into short lengths to prevent future obstructions to navigation, the following being a summary of the work done:

| | |
|---|---|
| Stumps removed | 395 |
| Shore snags removed | 971 |
| Leaning trees cut | 2,819 |
| Trees girdled | 18 |
| Square yards brush and willows cut | 3,875 |
| Points removed with explosives | 2 |

It was intended to make the proposed examination of this stretch of river when the Red River survey party passed down, but at the time the stage of water was too high, and it has been deferred until a more favorable opportunity.

The earlier surveys about Scopini Cut off and Tones Bayou were not connected with those of upper Red River by continuous levels, so that comparison with those of recent date can be made only approximately from the height of the bank ends of the old dam that was destroyed; but this method is close enough to show how great the general improvement is. Discharge observations taken twenty years ago gave about one-quarter to Little River, the rest escaping through Tones Bayou or over the banks into Bayou Pierre. Now not less than two-thirds of the flood is carried by Little River, and since this stretch has been leveed on both sides to grade from 2 to 3 feet above high water of 1892, the greatest flood recorded, I have no doubt that Little River soon will be able to carry the whole. The discharge measured at Shreveport at the top of the flood of 1892 was 6,400 cubic meters, say over 220,000 cubic feet per second. But as the Fabian policy has been found best as well as cheapest, it will be safer to delay closing Tones Bayou; or if any work of the kind should be found needful, then to begin with low dams or sills, as was done at Atchafalaya, gradually raising them from the first height of, say, 6 feet above lowest water until high enough to give foundation for a dam to join and complete the levees. This method of closing the outlet that has been the subject of so much acrimonious discussion, and upon which so much has been spent in vain, would have the double advantage that it should not cause alarm and that the dam could not be destroyed except by the use of explosives in considerable amounts, which would bring down a crowd of witnesses upon the persons attempting it. It may be added, also, that with the improvement of the river and the extension of the levee system the sentiment of the general public upon the subject of outlets has undergone a healthy change, and therefore it is even probable that there would be no interference either by violent or legal means, although the engineer in charge should build the dam at once to full height. Owing to the difficulty of doing work of the kind by contract, and to the lack of plant, it is estimated that $25,000 would be required for the sills and for revetting each bank at the ends to prevent flanking.

No separate estimate is submitted for Little River, and after the balance on hand is spent any further work that may be required from time time should be done as part of the general improvement.

## CONSTRUCTION OF LEVEES.

My report for the fiscal year 1891 contained estimates amounting to $158,000, for "repairing and enlarging the State levees by joining with the State engineers and levee boards, for the purpose of confining the waters of Red River to the adopted channel, thereby improving and giving ease and safety to the navigation of the river." (Report Chief of Engineers, 1891, p. 1958.) The total amount appropriated for improving Red River, Louisiana and Arkansas, by act of July 13, 1892, was $145,000, or 36¼ per cent of my estimates of $400,000, and upon this basis the Secretary of War allotted for levee work the sum of $57,275, which was apportioned as follows:

| | |
|---|---|
| For building Richmond Bayou and Pruitt levees, Louisiana, and Blanton Bluff and Bargetown Levee, Arkansas and Louisiana | $45,000 |
| For completing Bayou Pierre and Dixie Levee, Louisiana, in conjunction with State and private parties | 4,000 |
| For completing railroad to Mack's Bayou Levee, Louisiana, in conjunction with State and Bossier Levee board | 2,000 |
| For repairing Bargetown Levee, Louisiana | 1,500 |
| For mattress and ballast for strengthening Sale and Murphy dam, Louisiana | 775 |
| For clearing right of way from Sale and Murphy dam southward preliminary to construction of levee to join line projected by State engineers below | 1,800 |
| Reserving for contingencies and inspection | 2,200 |
| Total allotted for levee work | 57,275 |

Richmond Bayou, Pruitt, and Blanton Bluff and Bargetown levees were advertised October 20, 1892, and the following proposals were received and opened at the United States Engineer Office, Vicksburg, Miss., at 12 o'clock noon, November 5, 1892, viz:

| No. | Name and address of bidder. | Price per cubic yard. | | |
|---|---|---|---|---|
| | | Blanton Bluff and Bargetown Levee. | Richmond Bayou Levee. | Pruitt Levee. |
| | | *Cents.* | *Cents.* | *Cents.* |
| 1 | Jas. H. Fullilove, Shreveport, La | | 24⅛ | 18⅞ |
| 2 | McLaughlin Brothers, Memphis, Tenn | 24 | 21 | 22⅛ |
| 3 | J. S. McTighe & Co., Memphis, Tenn | 25 | 23 | 23 |
| 4 | James N. Ogden, Baton Rouge, La | | $17\frac{99}{100}$ | 15⅛ |
| 5 | John Dordan & Michael Hunt, Missionary, La | 14⅓ | | |
| 6 | Robert K. Colquitt, Shreveport, La | | 24¾ | 19¾ |
| 7 | Thomas J. Martin, Missionary, La | 16 | | |
| 8 | S. D. Moody & Co., limited, New Orleans, La | 18½ | $17\frac{9}{10}$ | $16\frac{9}{10}$ |
| 9 | A. P. Martin, Waterproof, La | 25 | 24⅓ | 22⅛ |
| 10 | C. F. DeGaris, Memphis, Tenn | 18⅞ | 19 | 20 |

The lowest bids were accepted, and contracts requiring that work be commenced December 1, 1892, and completed March 1, 1893, were made as follows:

For Blanton Bluff and Bargetown Levee, John Dordan and Michael Hunt, contractors; for Richmond Bayou Levee, S. D. Moody & Co., limited, contractors; and for Pruitt Levee, James N. Ogden, contractor.

Richmond Bayou Levee, on left bank of the river, extends from the State levee near St. Charles Bayou, about 12 miles below Shreveport, downstream 3,506 feet to a junction with Pruitt Levee opposite Lattier Cut-off, and crosses a branch of St. Charles Bayou and Richmond and Lays Bayous. This levee was completed February 25, 1893, and contained 58,551.9 cubic yards.

Pruitt Levee, a continuation of Richmond Bayou Levee, extends from a junction with the latter downstream 6,041 feet to the beginning of the new State levee below. Owing to unavoidable delays on account of sipage water, etc., the time for completing this work was extended from March 1 to April 1, 1893. The line was completed the latter date, and measured 91,008.59 cubic yards.

Blanton Bluff and Bargetown Levee, on right bank of the river, extends from the high land at Blanton Bluff, Ark., 70¾ miles above Shreveport, La., downstream 9,340 feet to a junction with the Bargetown Levee, built by the State of Louisiana in 1891, above and joining the Sale and Murphy dam. The amount of earthwork required for constructing this line is estimated at about 126,000 cubic yards. The contractors have met with frequent and unavoidable delays in its construction on account of continued high stages of the river and rains, which kept the ground wet and muddy and the barrow pits filled with water for a large proportion of the time. Situated at the head of the old raft, and only 10 miles below Sulphur River, which acts as a reservoir, the period of high water along this stretch is prolonged to a greater extent than observed on any other part of Red River, and for these reasons the time for completing the levee was extended to July 31, 1893. The amount of embankment completed ready for sodding and which had been accepted to June 30, 1893, was 91,660 cubic yards; in addition to which there had been placed at incomplete stations, not measured for acceptance, about 7,000 cubic yards.

The work of continuing the construction of Bayou Pierre and Dixie Levee, Louisiana, by hired labor, under supervision of overseer C. J. Coney, was begun by the United States January 21, 1893, and suspended February 28, when the funds allotted for the purpose ran out. This levee extends from the highlands on the right bank of the river near Shreveport downstream to the line of levee on Dixie plantation at Shreve Cut-off, 6 miles below Shreveport, crossing Bayou Pierre and the arms of old River between Hart and Shreve islands and between the latter and Dixie plantation. The work was done with an allotment of $4,000 from the State of Louisiana, an allotment of $4,000 by the United States, and the balance by private subscription from persons whose lands will be benefited and protected by the levee, and was completed early in April, 1893. The amount of embankment built by the United States was 25,164 cubic yards, costing about 15 cents a cubic yard, exclusive of superintendence.

The United States, the State of Louisiana, and the Bossier levee board each made allotments for the purpose of extending and completing the line on the left bank of the river from the railroad embankment opposite Shreveport down to and across Mack's Bayou, known as the "Railroad to Mack's Bayou Levee," and the Chief of Engineers having authorized that agreement be made with the bidder accepted by the State board of engineers, to pay him the amount allotted by the United States when the work should be completed and accepted, the line was advertised by the State board of engineers May 22, 1893, and proposals were opened at their office at New Orleans, La., May 31. Nine bids were received, the lowest being that of John T. Martin, of Shreveport

La., who agreed to complete the work by October 1, 1893. This levee will require about 60,000 cubic yards of earthwork, for which the United States will pay $2,000, the Bossier levee board $2,500, and the State of Louisiana $585; a total cost of $5,085, or equivalent to 8.475 cents a cubic yard. Agreement to pay the part apportioned by the United States on completion of the levee was entered into with contractor Martin June 15, 1893, as that method of doing the work was most economical and advantageous to the United States.

The repairs of the Bargetown Levee and Sale and Murphy Dam, and clearing the right of way for the projected levee below the latter, for which $4,075 were apportioned, had not been commenced at the close of the fiscal year, as the work would interfere with that under contract from Blanton Bluff to Bargetown, on account of the isolated location rendering labor scarce and leaving the contractors dependent on the neighboring planters to a great extent for the use of teams. As soon as the work under contract is finished, it is intended to commence the remainder of the levee work projected, which can be completed rapidly during dry weather this summer or fall.

The following table, compiled from information furnished by the board of State engineers of Louisiana June 21, 1893, shows in a concise manner the large amount of levee work undertaken on Red River during the year, nearly all of which is finished; and it will be observed that the quantity done by the United States is only 10 per cent of the aggregate, and the cost less than 9 per cent.

*Tabulated statement of levee work on Red River undertaken during the fiscal year ending June 30, 1893, by the United States, the State of Louisiana, and local levee districts.*

| No. | Name of levee. | Length of line. |  | Cubic yards. | Price per cubic yard. | Cost. | Per cent of work done. |
|---|---|---|---|---|---|---|---|
|  |  | New levee. | Enlargement. |  |  |  |  |
|  | *In Caddo Parish, Louisiana.* |  |  |  |  |  |  |
|  | By United States: | *Feet.* | *Feet.* |  | *Cents.* |  |  |
| 1 | Blanton Bluff and Bargetown *a* | 9,340 | ............ | 126,000 | 14½ | $18,270.00 | 80 |
| 2 | Bayou Pierre to Dixie *b* | (*) | ............ | 25,164 | 15 | 3,774.60 | 100 |
|  |  | 9,340<br>1.8 miles.] | ............ | 151,164 | ........ | 22,044.60 | ........ |
|  | By State of Louisiana: |  |  |  |  |  |  |
| 1 | Thompson | 3,087 | 4,048 | 40,341 | 18½ | 7,463.08 | 100 |
| 2 | Bayou Pierre to Dixie | 11,006 | 3,994 | 97,452 | ........ | 4,000.00 | 100 |
| 3 | Staten Point | 4,683 | ............ | 75,000 | 10.72 | 8,040.00 | 10 |
|  |  | 18,776<br>[3.6 miles.] | 8,042<br>1.5 miles.] | 212,793 | ........ | 19,503.08 | ........ |
|  | By Caddo levee district: |  |  |  |  |  |  |
| 1 | Cavitt and Dole | 2,615 | 16,273 | 47,648 | 23½ | 11,197.28 | 100 |
| 2 | Coushatta and Dooley Bayou | 7,200 | ............ | 51,331 | 35 | 17,965.85 | 80 |
| 3 | Egypt | 15,041 | ............ | 63,825 | 18 | 11,488.50 | 100 |
| 4 | Wild Lucia | 9,600 | ............ | 36,851 | 18 | 6,633.18 | 100 |
| 5 | Cedar Bluff and Crescent | 15,500 | ............ | 66,432 | 18 | 11,957.76 | 100 |
| 6 | Wood Place and Cowhide Bayou | 8,108 | ............ | 51,686 | 17½ | 9,045.05 | 100 |
| 7 | Rush Point | 7,896 | ............ | 43,468 | 17½ | 7,606.90 | 100 |
| 8 | Briarfield | 5,525 | ............ | 25,974 | 17½ | 4,545.45 | 100 |
| 9 | Uni and Hayti | 9,391 | 1,240 | { 39,748<br>{ 13,082 | 14½ }<br>17½ } | 8,052.81 | 100 |
| 10 | Dixie and Extension | 6,259 | 1,868 | 72,039 | 19.93 | 14,357.37 | 80 |
| 11 | Eagle Bend | 2,035 | ............ | 25,814 | 18.94 | 4,889.17 | 100 |
| 12 | Bagley | 5,918 | ............ | 26,313 | 12.9 | 3,394.38 | 10 |
| 13 | Kentucky | 1,650 | ............ | 16,246 | 21.94 | 3,564.37 | 100 |
| 14 | Riverdale and Levy | 9,837 | ............ | 107,268 | 20.73 | 22,236.65 | 100 |
| 15 | Ferryfield *c* | ............ | 2,200 | 14,000 | ........ | 600.00 | ........ |
| 16 | Long Point | 7,300 | ............ | 66,402 | 17 | 11,288.34 | 100 |
| 17 | Brown | 5,084 | ............ | 51,612 | 11.96 | 6,172.80 | 20 |

* See State work.

*a* Upper end in Miller County, Ark.

*b* Built by hired labor in conjunction with work of State and private parties.

*c* Just placed under contract.

*Tabulated statement of levee work on Red River, etc.*—Continued.

| No. | Name of levee. | Length of line. |  | Cubic yards. | Price per cubic yard. | Cost. | Per cent of work done. |
|---|---|---|---|---|---|---|---|
|  |  | New levee. | Enlargement. |  |  |  |  |
|  | *In Caddo Parish, La.*—Cont'd. |  |  |  |  |  |  |
|  | By Caddo levee district—Cont'd. | *Feet.* | *Feet.* |  | *Cents.* |  |  |
| 18 | Cash | 3,446 | 551 | 27,695 | 20½ | 5,677.47 | 100 |
| 19 | Pascagoula | 8,943 | 957 | 61,013 | 18⅜ | 11,211.13 | 100 |
| 20 | Logie Lea | 7,142 | 700 | 36,712 | 16.45 | 6,039.12 | 100 |
| '1 | Campobello | 5,550 | ........... | 40,274 | 17 | 6,846.58 | 100 |
|  |  | 144,040<br>27.3 miles.] | 23,792<br>4.5 miles.] | 985,433 | ....... | 184,770.16 | ....... |
|  | *In Bossier Parish, La.* |  |  |  |  |  |  |
|  | By United States: |  |  |  |  |  |  |
| 1 | Richmond Bayou | 3,506 | ........... | 58,551.9 | 17.9 | 10,480.79 | 100 |
| 2 | Pruitt Levee | 6,041 | ........... | 91,008.6 | 15½ | 14,106.34 | 100 |
| 3 | Railroad to Mack Bayou *a* | (*) | ........... | 23,598⅞ | 8.475 | 2,000.00 | 20 |
|  |  | 9,547<br>1.8 miles.] | ........... | 173,159 | ....... | 26,587.13 | ....... |
|  | By State of Louisiana: |  |  |  |  |  |  |
| 1 | Clay and extensions | 6,185 | 5,886 | 56,814 | 10 | 5,681.40 | 100 |
| 2 | Schenicks and extension *b* | 1,188 | ........... | 20,000 | 9.95 | 1,990.00 | ....... |
| 3 | Sunny Point | 2,540 | ........... | 36,908 | 9¾ | 3,598.53 | 90 |
| 4 | Railroad to Mack Bayou | 11,329 | 800 | 6,902⅝ | 8.475 | 585.00 | 20 |
|  |  | 21,242<br>4.0 miles.] | 6,686<br>1.3 miles.] | 120,625 | ....... | 11,854.93 | ....... |
|  | By Bossier levee district: |  |  |  |  |  |  |
| 1 | Willow Chute | 12,362 | 3,000 | 142,062 | 22.45 | 31,892.92 | 100 |
| 2 | Gold Point | 3,800 | ........... | 59,685 | 19 | 11,340.15 | 100 |
| 3 | Riverside | 5,800 | ........... | 47,413 | 15½ | 7,349.01 | 100 |
| 4 | Cash Point | 3,821 | ........... | 37,015 | 12½ | 4,626.87 | 100 |
| 5 | Shady Grove | 5,651 | ........... | 53,548 | 15½ | 8,299.94 | 100 |
| 6 | Vinson Bayou | 3,400 | 850 | 16,216 | 14 | 2,270.24 | 100 |
| 7 | Railroad to Mack Bayou | (*) | ........... | 29,498⅝ | 8.475 | 2,500.00 | 20 |
| 8 | Nicholson Crevasse | 4,318 | ........... | 65,953 | 21 | 13,850.13 | 100 |
| 9 | Curtis | 5,265 | ........... | 70,635 | 16½ | 11,654.78 | 100 |
| 10 | Curtis, No. 2*c* | ........... | 4,000 | 20,000 | 10 | 2,000.00 | ....... |
| 11 | Childers | 6,900 | ........... | 111,373 | 20 | 22,274.60 | 100 |
| 12 | Scopini | 6,086 | ........... | 118,000 | 20 | 23,600.00 | 100 |
| 13 | Grappes Repair | ........... | 3,900 | 5,000 | 12½ | 625.00 | 100 |
| 14 | Clydesdale | 1,861 | 4,260 | 30,000 | 13½ | 4,050.00 | 80 |
| 15 | Dortch | 4,741 | ........... | 54,000 | 19¾ | 10,665.00 | 100 |
| 16 | Mercer | 6,274 | ........... | 56,000 | 19¾ | 11,060.00 | 100 |
| 17 | Navigator Point | 3,263 | 300 | 25,000 | 14 | 3,500.00 | 100 |
| 18 | Hopewell | 5,600 | ........... | 51,000 | 18 | 9,180.00 | 100 |
| 19 | Elm Grove | 4,223 | ........... | 35,621 | 14 | 4,986.94 | 100 |
| 20 | White House | 7,750 | ........... | 53,529 | 14 | 7,494.06 | 100 |
| 21 | Knox Point | 10,133 | ........... | 73,208 | 17½ | 12,811.40 | 100 |
|  |  | 101,248<br>19.2 miles.] | 16,310<br>3.1 miles.] | 1,154,757 | ....... | 206,031.04 | ....... |
|  | *In Rapides Parish, La.* |  |  |  |  |  |  |
|  | By State of Louisiana: |  |  |  |  |  |  |
| 1 | Hathorn | 3,997 | 700 | 69,176 | 17 | 11,759.92 | 100 |
| 2 | Duncan *c* | 1,366 | 4,259 | 60,000 | 12.49 | 7,494.00 | ....... |
|  |  | 5,363<br>1.0 mile.] | 4,959<br>1.0 mile.] | 129,176 | ....... | 19,253.92 | ....... |
|  | By Red River, Atchafalaya and Bayou Boeuf levee district: |  |  |  |  |  |  |
| 1 | Bayou Rapides | 4,700 | ........... | 26,585 | 19 | 5,051.15 | 100 |
| 2 | Cummings Point | 7,456 | 2,877 | 139,818 | 17½ | 24,468.15 | 100 |
| 3 | Connella | 1,498 | ........... | 25,634 | 19.95 | 5,113.98 | 100 |
| 4 | Rogers | 821 | ........... | 12,517 | 19½ | 2,440.82 | 100 |
| 5 | Hathorn to Beaver Dam | ........... | 3,300 | 23,168 | 19.24 | 4,457.52 | 100 |
| 6 | Bringol | 5,468 | 1,597 | 91,259 | 22 | 20,076.98 | 100 |
|  |  | 19,943<br>3.8 miles.] | 7,774<br>1.5 miles.] | 318,981 | ....... | 61,608.60 | ....... |
|  | **Total work undertaken** | 329,499<br>62.4 miles.] | 67,563<br>12.8 miles.] | 3,246,088 | ....... | 551,653.46 | ....... |

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* See State work.

*a* Work commenced under agreement of June 15, in conjunction with State and district.

*b* Just placed under contract.

*c* Under contract.

The Board of State Engineers submitted approximate estimates June 13, 1893, "for levee work needed in the near future, of prime importance to the Caddo and Bossier levee districts." The amounts were given somewhat in detail, upon preliminary locations on the maps of Red River furnished by this office. The Board stated that—

> The selection of the localities named is made with the object and view of improving, as far as possible at this time, the stretches of levee lines already constructed, and to make them continuous, as far as they go, from their upper to their lower limits, and the yardage involved is, of course, but a fraction of what would be required to extend the present lines so as to establish a comprehensive levee system for the protection of the entire scope of country embraced within the boundaries of the two levee districts named alone, not to speak of the balance of the valley of Red River.

Part of the system would extend above the State line, for which, of course, the State engineers of Louisiana can not provide. There are also stretches of river not yet included in any levee district; and finally there is the Red River, Atchafalaya, and Bayou Boeuf levee district in which only a small beginning has been made. It will be seen from the statement of work done during the past fiscal year that only a small proportion has been paid for by the State, the greater part having been built with the proceeds of levee district bonds. The State fund is small, and is used sparingly to eke out district work, or for repairs or emergencies, and to provide for engineering contingencies, the State engineers being the professional advisors to the several boards. In order to expedite this work and give practical benefit to navigation, while helping the people who have assumed such great burdens of taxation, I submit the following estimates, which can be expended economically and profitably during the next two years, as follows:

| | |
|---|---|
| Caddo district above and below Shreveport, 550,000 cubic yards, at 20 cents | $110,000 |
| Bossier district above and below Shreveport, 500,000 cubic yards, at 20 cents | 100,000 |
| Red River, Atchafalaya and Bayou Boeuf district, 700,000 cubic yards, at 20 cents | 140,000 |
| Red River in Arkansas, and between districts, 500,000 cubic yards, at 20 cents | 100,000 |
| Closing outlets and draining impounded water from Choctaw Bayou, 200,000 cubic yards, more or less, at 25 cents | 50,000 |
| Total, 2,450,000 cubic yards | 500,000 |

The general average price is assumed at 20 cents the cubic yard, the actual cost depending upon too many conditions to admit of close estimates until the lines shall have been staked out, but it is believed that this will leave sufficient margin for engineering, administration, and inspection. The engineer in charge would be able to coöperate to better advantage with the State engineers and levee boards and to apply the funds more economically and intelligently after consulting with them, if the appropriation should be made in a lump sum to be allotted by the Engineer Department, subject to the approval of the Secretary of War. This method was followed under the provisions of the item for Red River in the last river and harbor act and has worked admirably, not only in saving the time that would have been required for local surveys and projects for each line, but in allowing the United States Engineer to fit in with and supplement the State work to best advantage. It is pleasant to mention that the most cordial and harmonious relations have subsisted between the local engineer and the State engineers and levee boards, and that a large amount of continuous fine levee work has been made possible through such coöperation.

Red River has also behaved with great moderation during this flood season, running at a comfortably bank-full stage, or 10 or 12 feet below great high waters, although the precipitation in the valley was by no means small. The new levees therefore will have ample time to consolidate and become completely sodded before the autumn rains, so that there should be no fears for their safety if called upon to resist a high stage of river.

The United States levees were built at a net grade 3 feet above flood of 1892, but I am of the opinion that a higher grade should be required, because the high-water line is not uniform in slope, as may be seen by the hydrograph giving the flood lines of 1890 and 1892, and may be raised temporarily above its apparent limits at any section by local obstructions, although the general tendency will be to reduce its superior limits as the work of improvement goes on. I should urge making the net grade 5 feet above highest water recorded to make the levee system safe and to allow for deterioration, especially in levees at remote stations, thus giving about 36 feet thickness at the high-water line for levees with the usual slopes and 6-feet crown.

## ALEXANDRIA.

The approved project for work at Alexandria, given in my last annual report (pp. 1584–1586, Report Chief of Engineers, 1892), contemplated improving the channel at the Upper Falls by dredging, so as to give greater ease and safety to the passage of boats at low water, and using the material excavated for protecting the town front from erosion by the current of the river.

I visited boat builders at Jeffersonville, Ind., and St. Louis, Mo., the early part of September, 1892, for the purpose of arranging to obtain barges required at this and other works, but found the builders unwilling to make any agreement for furnishing them on account of the provisions of the eight-hour law of August 1, 1892. As the work had to be done at low water, it was commenced with such plant as could be obtained. Two old barges, used by the Union Bridge Company in building the bridge at the Upper Falls the preceding year, were purchased and repaired for temporary use until others more suitable could be had.

The excavation at the falls was done by means of the United States dredge *Lone Star*, G. W. Phillips, engineer in charge. The dredge was fitted with steel-pointed spuds and a heavy steel lip on the dipper, to which steel teeth were attached; and the soft material, a silicious marl rather than stone, as a general thing, was removed without drilling or blasting, only a small quantity of explosives having been needed during the progress of the work. The material was dumped by the dredge on the barges, which were dropped down to the town front, about 2 miles, unloaded and cordeled back. The cost of hiring a towboat for this purpose was found to be too great an expense, the lowest offer having been at the rate of $75 a day, and none of the steamers belonging to the district could be spared until December 19, when the snag boat *Wagner* arrived at Alexandria from Ouachita River.

The revetment work was done under the supervision of Overseer C. J. Coney. Operations commenced September 14, and were continued without serious interruption until December 26, 1892, when the dredge broke down. As it was found that the repairs needed would take considerable time, and as the river was rising so that it soon would reach a stage too high for further work, on the latter date the force was discharged and the plant laid up.

When the work commenced in September it was found impracticable to carry out the recommendation of the division engineer to revet the bank between Scott and Beauregard streets without grading, as it was nearly vertical, and as the crib dyke built in 1884–'85 had deteriorated very much the stone excavated was deposited just above and along the line of the dyke until October 12, forming a protection dam 129 feet long, with crest about 5 feet above zero of the gauge, or nearly 9 feet above low water. At that time authority was granted by the mayor of Alexandria, and permission given by the property owners to grade the bank to a height of about 20 feet above zero of the Alexandria gauge, leaving a vertical bank, about 12 feet in height, above the graded portion. Grading was commenced October 13, and the lower bank below Scott street was sloped to about 1 upon 4, except the last 91 feet above Beauregard street, which was sloped about 1 upon 2. The graded portions were paved with a layer of stone to a depth of 2½ feet, but as it was found that in course of solidifying the shrinkage amounted to at least 33⅓ per cent, the depth was increased to 3½ feet. The work of revetting the bank was completed December 23, after which the material excavated was used in commencing a dike at foot of Beauregard street, on which work had to be stopped when the dredge became disabled.

The following is a summary of the work done at Alexandria during the year:

| | | |
|---|---|---|
| Rock excavated from channel at Upper Falls and transported in barges to front of Alexandria | cubic yards.. | 10,242 |
| Rock used in building dam for protecting and strengthening crib dike | cubic yards.. | 2,787 |
| Rock used in revetting bank and making foundation for same | do... | 7,181 |
| Rock placed in dike at foot of Beauregard street | do... | 274 |
| Area of bank graded to a slope of about 1 upon 4 | feet.. | 630 by 50 |
| Area of bank graded to a slope of about 1 upon 2 | do... | 91 by 50 |
| Earth moved in grading bank | cubic yards.. | 11,243 |
| Bank paved with rock to an average depth of 3¼ feet, and to a height of about 20 feet above zero of gauge | linear feet.. | 721 |

During the high-water season since the work stopped the dredge was hauled out and the bottom repaired and calked, and the broken parts of machinery replaced, and the boat is ready to resume operations when the water reaches a sufficiently low stage.

The project first submitted contemplated a longitudinal dike about 4 feet above lowest water, with occasional spurs to the foot of the right bank, to guide the river at low and medium stages, and to check the current within the dike, so that the inclosed space should gradually fill. The revetment under the amended project has withstood the river at the higher stages as well as should have been expected under the conditions imposed, but the method is not satisfactory and should not be repeated. The excavation at the Upper Falls has improved that difficult piece of navigation not a little, and only a small amount of dredging is needed to make it safe. It is not believed that any marked reduction of depth will be found at the head by reason of the increased discharge section, but if any shall be noticed at the next extreme low stage it may be corrected by raising an old low dam, date unknown, extending out obliquely from the right bank above the cut. The maps of the Red River survey soon will be finished below this reach, and, with the information collected about high and low water limits, discharge, etc., should furnish the means for studying this problem, which is difficult enough, if only because high-water discharge is not less than fifty times that at low water.

If it should be found that the rock obstructions are confined to t
stretch of river between and near the Upper and Lower Falls, it is n
improbable that the best improvement may consist in cutting dow
boldly and obliterating them, leaving the river to distribute its fa
over this reach in prolonging its slope in less degree for some distan
above and below through natural scour. Locks and dams have bee
suggested and estimated upon for low-water navigation of this reac
but on every ground an open river is to be preferred if it can be ha
Aside from other objections, such as cost, delays, etc., the flood height
would be increased considerably by any form of dam, the width
river being too small to give sufficient spill, and this would requi
levees on both sides of the river several feet above present grade fo
many miles upstream.

Since the last work began the common council of Alexandria passe
a resolution urging the Member of Congress for that district to obta
for them an allotment of $50,000 for extending the work in front of an
below the town. If the bank were to be covered with mattress wor
and stone the amount asked for would be none too great, because
would have to be filled out instead of graded back, there being a leve
on the crest of the bank behind which is the principal business stree
Of course, if the object of the resolution is to get a fine paved levee fo
commercial purposes, the Alexandrians should pay for it themselve
and charge wharfage, as is done in other cities. But unless paved th
bank should not be driven over even if the slope were made gentle an
covered with earth or gravel, and as at best the slope in this case woul
be steep, if the work should be ordered, inclined piers or wharve
would be required. Assuming this work to be a necessity, since th
bank can not be graded back for the levee and street, the slope mus
be got by moving the foot riverward and holding it by a pile dik
about 4 feet above low water or about zero of the gauge, closing th
front by water-tight sheet piling and filling in the slope by dredgin
from the channel. After the material becomes consolidated it may b
graded and sodded like the present natural bank and the levee raise
and enlarged. If the bank should slough it may be that a covering
gravel would give it more permanence, and since it is desired to avoi
the use of expensive stone covering, only so much is estimated for
may be needed for riprap against the dike. The foregoing indicat
the line of experiment suggested in the remarks under general improv
ment. The inclined wharves would be open pile piers, oblique to th
bank line, at which boats might land at all stages. If compensatio
should not be expected for the privilege of being protected, the est
mate for this work, say, 2,500 linear feet, more or less, would be as fo
lows:

| | |
|---|---|
| 2,500 feet pile dike | $12,5 |
| Dredging, filling, and grading | 5,0 |
| 2,500 cubic yards stone | 7,5 |
| Incline wharves | 2,5 |
| Pro rata charge for general plant | 1,0 |
| Office supervision, and contingencies | 1,5 |
| Total | 30,0 |

Referring again to the excavation of the falls, I think it would b
safe to continue it, giving rather more attention to the Lower Fall
which is now the more difficult at low water for upstream boats. Th
first effect of increasing the depth at this point would be to shift th
break in slope upstream and reduce the depth by a small amount, bu
the latest map shows but one point between the two falls which migh

Photo-Lith. by A. HOEN & CO., Balto., Md.

become dangerous, and this could be reduced in advance by surface blasting and removed by the dipper dredge, which has been fitted specially to handle such material. The spoil may be put on the foot of the bank or in the dike. Fifteen thousand dollars can be spent to advantage in continuing this improvement.

## SHREVEPORT HARBOR.

Since the last report a resurvey of this reach has been made and mapped, and profiles and sections of all the surveys reduced to the same scales and drawn superposed for comparison. The outline map herewith, on which a few sections are given, was compiled from the originals, and shows the changes in bank line and depth since 1886. Section 10, about where the crossing is said to have been made on a fence rail in 1855, is now large enough to permit high-flood discharge at moderate velocity without danger of overflow; and its width may be increased somewhat, probably, without material reduction in the depth. But it is important to prevent the danger of further caving of the left bank to preserve the harbor, protect the levee system, and especially to prevent large escape into the swamps and lakes to the east and south. The length of front needing protection is somewhat greater than reported last year, and as work of the kind should be built as a whole the estimate should be increased to not less than $50,000.

The chief cost of revetment work for places distant from quarries is the ballast, and therefore it is desired to try holding the foot of the slope by a dike closed with sheet piling, as mentioned under Alexandria. Assuming that a dredge and pile-driver will be added to the plant and that the work will be done by purchase of material and hired labor, it is estimated that the dike will cost $4.65 and filling and grading 35 cents the linear foot. If covered thickly with stone about 3 cubic yards will be required per linear foot, which it will not be safe to estimate at less than $3 the cubic yard. It is thought that gravel may be substituted with advantage, and that possibly sodding the slope like the levees with Bermuda grass may answer if the bank is not too much exposed, as in many places along Red River steep banks have been noted thickly grassed down to the water's edge at low stages.

The experiment would be more complete if several kinds of protection were tried, dividing the work into three or more sections for the purpose. The pile dike should consist of piles about 30 feet long driven down to near zero of the gauge at 5-feet centers, with stringers front and rear, and lapped sheet piling of long 2 or 3 inch plank driven behind and bolted through a rear wale to the front piles and stringers. It is not thought that a rear row of anchor piles would be needed. They would increase the cost of the work very considerably, and if the dike should incline forward it would be quite as efficacious and much cheaper to strengthen weak places by driving piles against the front.

## SURVEY OF RED RIVER FROM FULTON, ARK., TO ATCHAFALAYA RIVER.

The value of the Red River survey has been tested practically during the past year by the State engineers of Louisiana in locating new levees. Twenty-eight sheets were traced in outline (scale 1:10000) and blue prints furnished on which the preliminary lines were marked, and the profiles constructed from the elevations noted on them and the grade fixed by the high-water line of 1892 furnished by this office. The State engineers reported that these maps were practical working drawings, and that they found it hardly necessary to make any changes in laying out the lines in the field. Thus much time and money were saved, and they were enabled to advertise and put so large an amount under contract during the working season.

The field sheets from Fulton to Atchafalaya were finished last year and the final sheets are now in hand, the principal draftsman being engaged on sheet 44 (381–388 miles), leaving about 16 sheets to be plotted and inked. The topographical work by hand and by mechanical process has reached sheet 37 (349–354.5 miles), and from the rate of progress during the past year it is hoped that all will be finished during the next fiscal year, including the final lettering, index charts on small scale, and tracings for blue prints for levee work, according to the following estimate:

| | |
|---|---|
| Plotting and inking | $1,800 |
| Topography | 1,680 |
| Lettering and finishing | 600 |
| Tracing | 360 |
| Draftsmen's supplies | 60 |
| Total | 4,500 |

Before the maps are completed there should be a reconnoissance of the whole river, shore lines measured from the permanent stations and put on together with the new levees to date, and the maps published by photo-lithographic process. For working drawings and for convenience in plotting future changes, it would be well to have a small edition on the original scale of 1: 10000, and a larger edition for general use on 1: 20000 scale, giving sheets one-fourth the size of the original and conforming with the published maps of Mississippi River. An edition of 200 on the large scale, on good paper, is estimated at $2,500, and one of 500 on the small scale at $5,000.

While it would add to the value of the maps to carry secondary triangulation from Atchafalaya to Fulton, for which an estimate of $60,000 was made, this work may be postponed or omitted, but the transvalley sections and borings, and the determination of high and low water limits and discharge, should be prosecuted as far as possible. For these purposes and for the reconnoissances to note changes the sum of $13,000 is estimated. Deducting the amount available July 1, 1893, there will be required only $16,000 to be appropriated to complete the survey of over 500 miles of river, which will not suffer by comparison in cost, grade, or completeness with any work of its kind.

During the progress of the survey special efforts were made to recover points, benches, and water lines of former work. All of the early note books and maps that could be found were examined and reduced to the same datum and scale of the new survey with considerable measure of success, and the survival of a few benches of 1871–'72 has furnished the means for comparing discharge at places above and below Shreveport at intervals between 1872 and 1893. A few of the results are given in tables A and B, computed in the metric system, and confirm the statement made in this and earlier reports of the great increase of the river's capacity since the removal of the raft. Table A shows that the discharge of Red River below Cross Bayou at Shreveport, measured February 11, 1893, exceeded that of February 29, 1872, by 208 cubic meters (about 7,300 cubic feet) per second, although taken at a stage 2.55 meters (8.36 feet) lower. Table B shows that the discharge measured February 15, 1893, below Scopini Cut-off, at the head of the portion of Red River called Little River, was over three times greater than that found on March 11, 1872, while the proportion escaping through Tones Bayou in 1893 was only 12.6 per cent, as against 60 per cent in 1872. Again the discharge of Red River above the cut-off was nearly 46 per cent greater on February 15, 1893, although the stage of river measured on the Shreveport gauge was 3.6 meters (11.8 feet) lower than on March 11, 1872. Comparing the discharge on March 11, 1872, Table A, with that of February 28, 1891, Table B, it will be seen that the discharge at Shreveport in 1891 was more than three times the discharge in 1872, when the gauge heights differed by only 0.2 meter (0.6 foot). In other words, it now requires more than three times the quantity of water discharged in 1872 to hold the water surface up to the same height at Shreveport, or to a stage less than two-thirds the height between extreme low and high water. Two chance observations during low water in November, 1891, at Missionary, 69 miles above, and at Alexandria, 209 miles below Shreveport, compared with the flood discharges measured in 1892, give a basis for an estimate of the ratio between high and low water discharge, which may be assumed at 75 to 1 for the average, rising above 100 to 1 in the upper river and perhaps falling below 40 to 1 below Alexandria. Both tables show the progressive increase in the capacity of the improved river, and the diminishing capacity of the outlets, and furnish some notion not only of the improvement to navigation, but of the increased protection of the valley lands by the deepening of the river.

TABLE A.—*Discharge of Red River, Shreveport, La.*

[Cubic meters per second.]

| Date. | Upper Red. | Twelve Mile Bayou. | Cross Bayou. | Total. | Lower Red. | Water surface at Shreveport gauge. |
|---|---|---|---|---|---|---|
| Feb. 29, 1872 | *51.0 | †198.0 | ‡313.0 | 562.0 | §491.0 | 55.00 |
| Dec. 27, 1890 | | 223.0 | | | | |
| Feb. 23, 1891 | 285.7 | 496.7 | 686.6 | 1469.0 | 1449.0 | 56.31 |
| Feb. 28, 1891 | 267.5 | 448.2 | 497.6 | 1213.3 | 1262.0 | 55.69 |
| May 31, 1892 | 1376.0 | 1445.0 | 3245.0 | 6066.0 | 6281.0 | 59.74 |
| June 4, 1892 | 1209.0 | 1370.0 | 2493.0 | 5072.0 | 5396.0 | 59.25 |
| Oct. 19, 1892 | | 24.0 | | | | 48.73 |
| Feb. 11, 1893 | 268.0 | 323.0 | ‡100.0± | | 699.0 | 52.45 |

* Water surface, 55.7 meters Cairo datum.
† Water surface, 55.3 meters Cairo datum.
‡ Water surface, 55 meters Cairo datum.
§ Water surface, 54.6 meters Cairo datum.

Discharge at Alexandria November 17, 1891, 119 cubic meters.
Water surface at Alexandria November 17, 1891, 0.52 meter below zero.
Discharge at Louisiana and Arkansas State line November 21, 1891 (water surface, 63.23), 65 cubic meters.
Water surface at Shreveport November 21, 1891, 0.37 meter below zero.

TABLE B.—*Discharge of Red River.*

SCOPINI CUT OFF.

[Cubic meters per second.]

| Date. | Water surface, Tones Bayou. | Red River below. | Tones Bayou. | Total. | Red River above. | Water surface at Shreveport gauge. |
|---|---|---|---|---|---|---|
| Mar. 11, 1872 | 52.31 | 165 | 243 | 408 | 369 | 55.88 |
| Feb. 16, 1887 | 51.58 | 183 | 94 | 277 | 311 | 51.89 |
| Feb. 21, 1887 | 52.32 | 328 | 180 | 508 | 479 | 52.72 |
| Feb. 24, 1887 | 52.76 | 327 | 232 | 559 | 614 | 53.23 |
| Mar. 5, 1887 | 53.52 | 331 | 273 | 604 | 606 | 54.09 |
| Apr. 20, 1891 | 52.80 | 546 | 172 | 718 | 690 | 53.39 |
| Apr. 27, 1891 | 53.61 | 626 | 235 | 861 | 841 | 54.27 |
| Feb. 15, 1893 | 51.53 | 520 | 75 | 595 | Not taken. | 52.28 |

In measuring discharge it should not be expected to get identical results even under the same conditions, but only that the results should be comparable with one another and vary within small percentages. It is well known that discharge at the same stage will be greater on a rising than on a falling river, and it is pretty generally believed that rivers run in pulsations, so that different sets of careful observations on the same day will not be in perfect accord. But while the subject should be treated broadly and small attention given to the decimals in the final results, it is important that the sections should be sounded often with great care, that the meter be rated often, and that as many observations as possible be taken back and forth on the section for each set. The methods with rods and floats are neither economical nor adapted to streams of great discharge, and involve large observation parties and tedious delays, and, therefore, the Price electric meter has been used in all of the later work of the survey. This is a well-built, practical instrument, easily rated, not liable to injury with ordinary care, and so assembled that a great number of observations may be taken at varying depths in one position during a short interval. By using a steel cable stretched across the section, when the width is not too great, the boat from which the meter is operated may be shifted back and forth to any position on the section, thus permitting the observations to be increased very rapidly. In computing the results the graphic method has been used, not only as simpler and cheaper, but as more likely to be correct; and it was with these objects that the rolling planimeter was bought, which is described in Assistant Engineer Marshall's report.

It must be plain that the greater the number of soundings or velocity observations the more nearly will the plotted line approach a curve; and that if curves be drawn through the plotted points they can be traced more quickly by an instrument devised for recording the inclosed area, than by measuring and computation, or, in other words, by integrating mechanically than by the multiplication table or by logarithms; and if the precision of the instrument can be depended upon for an area error of even 1 per cent, it seems reasonable to expect a final result with less error than the sum of errors in computing a number of partial areas arithmetically. The rolling planimeter may be used on distorted areas as usually plotted for such work, by setting the vernier to record the number of square millimeters corresponding to the number of square meters of actual section, which may be done after a few trials upon a rectangle plotted to the same horizontal and vertical scales; for example, the horizontal scale may be 1–1000 and the vertical scale 1–100, giving the transformation scale of 10 to 1. In this way the discharge by the third method is given by the difference of readings in tracing the discharge areas. It is my opinion that time spent upon means of verticals, means of means, and the like, could be applied to better use in getting more correct soundings on sections and increasing the number of observations and sets for velocity; especially as the soundings can not be relied upon within 10 per cent or more in great high-water depths. The mean velocity of the stream is of no special value, and the discharges in partial areas are of still smaller consequence, the curves giving them well enough; the real things of importance being the maximum velocity and the maximum and minimum quantity of water to be expected at flood. To give discharge observation their greatest value the number of gauge staffs should be much greate than commonly thought necessary, and the locations made with thi object rather than only to accommodate river traffic; and then observa tions for discharge should be carried on simultaneously at a great number of critical points and through long periods of rising and falling water. But as it is not probable that funds ever can be had for such extensive work, only an approach can be made by interpolating a few gauges at the most important places for temporary use, and making discharge observations whenever a party should be conveniently near, making special observations at extreme stages. In this way a large amount of information can be collected which will grow in value with time, both for Red River and its tributaries and for the problems at its mouth.

The report of Assistant Engineer Marshall is given herewith for details:

### REPORT OF ASSISTANT ENGINEER H. M. MARSHALL.

UNITED STATES ENGINEER OFFICE,
*Vicksburg, Miss., June 10, 1893.*

CAPTAIN: I have the honor to submit the following report of operations on Red River survey during the current fiscal year, together with tabulations of all data now on file in this office, except such information as concerns low water, which, on account of its fragmentary character, is reserved for future additions to render significant:

Discharge of flood of 1892 was measured at Shreveport and Alexandria. Observations were made at time of highest gauge as well as just before and after at Alexandria, but the party reached Shreveport two days too late for the maximum stage there. During October and November a party went over the river from Shreveport to the mouth of Posten Bayou, taking shore line, high-water elevations and low-water soundings. During January and February high-water gauges were set at intervals of about 8 kilometers from Fulton, Ark., to Atchafalaya River, and at the same time high-water marks of 1892 were leveled to. Observers were engaged to make the observations twice daily, with the understanding that they were to be paid at the rate of $10 per month for the time covered by the observations. Notwithstanding the disparity between the work and the pay, the vigilance of observers has been highly gratifying, and promises great success in determining the next high-water slope. The stage since the gauges were set has not been sufficient to give more than isolated readings, which are not worth publishing.

Work in the office has progressed so that nearly all data are in available shape for ready reference. The profiles of banks, bottom, and outlets can not be made in advance of the mapping, but can progress at a much more rapid rate, so that both will be completed at the same time. The notes are ready for profiling from Spring Bank to Coushatta, and profiles have been made over a reach of 20 miles adjacent to Cottonwood Bayou and over that part of the river from Shreveport to Whitehall Landing. Map sheets to scale 1: 10,000 have been outlined in ink from Fulton, Ark., to Boyce, La., making 44 in number and leaving about 19 yet to plot. The topographical signs have been put on 37 sheets; those above Shreveport were made by Draftsman F. Y. Parker, by hand, and those below by Draftsman O. A. Ljungstedt, by means of the printing device first used in the office of the Mississippi River Commission, some modifications having been made in this office. Tracings and blueprints were made of 37 sheets, and copies of the prints were furnished the Louisiana State engineers' office for use in levee location.

All reliable data are being thoroughly sifted from previous surveys to be incorporated in the tabulations and profiles. The comparison of former and present beds, water surface, and discharge can not fail to be fruitful of both knowledge for practical application and teachings of the relation of elements of a river's flow. The borings and low-water gauging will be done by a small party during low water the coming season. Special examination will be made of the shoal crossings to discover their cause and to determine the remedy.

From the head of Atchafalaya River to Shreveport the survey is accurate, well marked by monuments, quite comprehensive, and, except the hydrography, is thoroughly checked. Above Shreveport it is as good as can be without a system of triangulation and precise levels, the latter deficiency being in part atoned for by accurate wye levels carefully checked.

A description of methods of survey with results obtained is given herewith under the heads—Base-measuring apparatus; triangulation; hypsometry; topography, and hydrography.

### BASE-MEASURING APPARATUS.

Following the method under the Mississippi River Commission, which was further elaborated under the Missouri River Commission, of measuring base lines with tapes, it was desirable to perfect the method and reduce the bulk of instruments. Assistant Engineer O. B. Wheeler's remark, "It was believed that the main source of error was due to an uncertain temperature correction," being without doubt the true explanation of the difficulty to be overcome, use was made of a brass and a steel tape, whose difference in length, due to difference in rate of expansion, measured the temperature of the tapes themselves; the same thing on a different plan having been heretofore done by Prof. Jäderin, of Stockholm.

To obtain as nearly the same section as practicable the tapes, which are about 100 meters long, were rolled under special order by J. A. Gowdey & Son, of Providence, R. I. Tests made under direction of Col. Flagler, Ordnance Department, U. S. Army, at Watertown Arsenal, developed the following characteristics:

*Tests of brass and steel tapes.*

| Characteristics. | Brass tape. | Steel tape. |
|---|---|---|
| Sectional dimensions (inch) | 0.128 by 0.0128 | 0.129 by 0.0130 |
| Sectional area (square inch) | 0.0016 | 0.0017 |
| Ratio of elongation (load, 40 pounds) | 0.0008 | 0.0006 |
| Ratio of set | 0.0001 | 0.0001 |
| Tensile strength (pounds per square inch) | 60,000 | 227,650 |

That they might be subject to the same temperature they were stretched side by side and measurements made simultaneously.

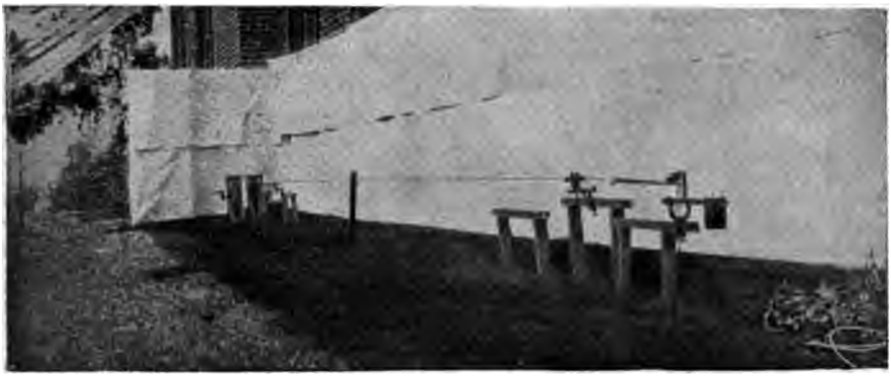
The U. S. Coast and Geodetic Survey department very courteously graduated the tapes without charge, displaying great skill in copperplating the steel tape over the space occupied by the graduation and in engraving on both tapes. The steel tape was standardized before graduation by using paper scales glued to the tape, and the length of the brass tape found by several comparisons at varying temperatures. Graduation extends both ways from the standard marks near the ends over a space of 2 decimeters divided to millimeters. The numbers run both ways from the zeros. The tapes are kept and transported on reels about 15 inches in diameter, made like single sheaves, with three-eighths-inch opening, turning in a frame by a crank and handle. The instruments for applying and measuring tension are an adaptation of those used by Assistant Engineer Wheeler under the Missouri River Commission. The method and means of marking the ends of the tape lengths are believed to be original. In quick grasp of the ideas and excellent workmanship in carrying out the designs, Messrs. W. and L. E. Gurley, of Troy, N. Y., exhibited preeminence in their calling, and aided in no small degree in the undertaking. The apparatus consists of—

1. Four tension frames.
2. Two balance beams.

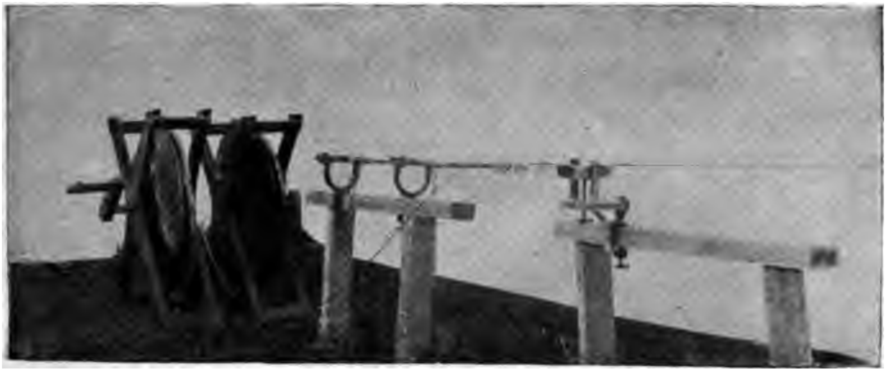
Tension frame consists of a clamp and frame of brass shown in vertical projection, side and end, and horizontal projection, Plate 1. The clamp has two arms above it, to which is screwed the three-sided rectangular frame. A screw working in one end moves the brass block, which is guided by flanges sliding in grooves in the sides of the frame. The screw is attached to the block, as shown in section *AB*, by a collar, so that it will not be disengaged by turning. Two small hooks are screwed in the front of the block to attach the tape chains when the frame is used at rear end of the tapes. A triangular space is cut out of the block, and in the sides adjacent are cut seats for the knife edges *r* of the balance beam to rest in.

The balance beam, shown in side view and projection, Plate 2, is brass, and has steel knife edges, *r*, on which it rests, and knife edges, *s*, about which turn the stirrups of the steel hook to which is attached the front end of the tape chain. On top of the upper short arm of the beam is a small level vial in a case attached by adjusting screws to the beam. On the end of this short arm is a screw on which works a counterpoise to balance the beam without the pea. The long arm of the beam is divided so that the mark 5, which is the same distance from the knife edges *r*, on which the beam rests, as are the knife edges, *s*, about which the stirrups turn, shall indicate a tension equal to the weight of the pea, and twice that distance a tension twice the weight of the pea. The pea weighs 5 pounds, and its mass is so distributed that the center of gravity lies in a vertical plane perpendicular to the face through the index point.

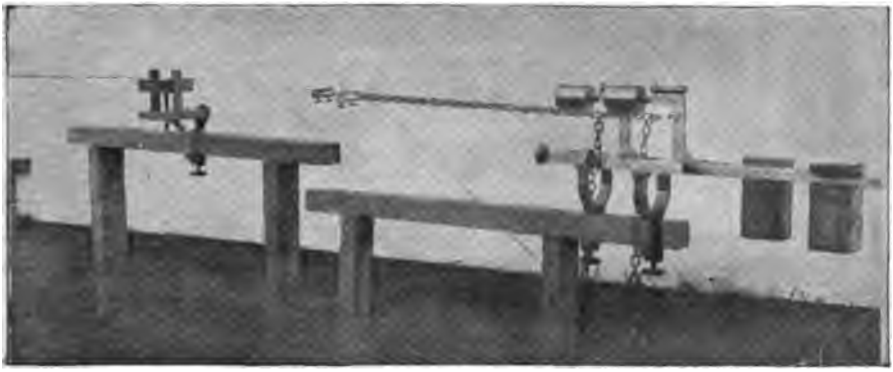
3. Two verniers.



General view.



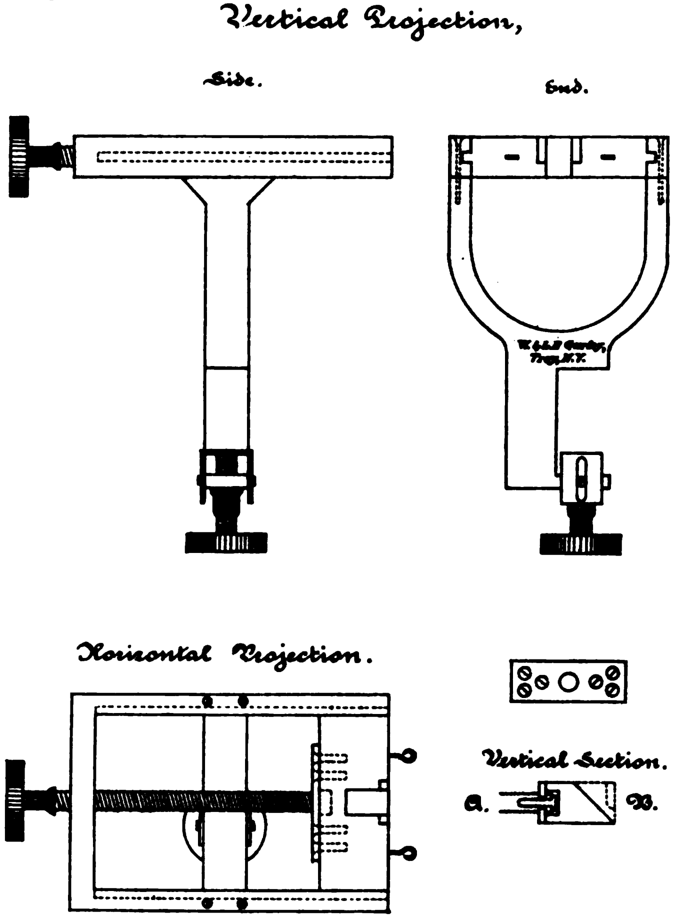
Rear end.



Front end.

RED RIVER SURVEY—BASE-MEASURING APPARATUS.

Plate No. 1.



# Tension Balance
for
# Base Measuring Tapes,
## Red River Survey.

Designed under direction of Capt. J. H. Willard, U.S. Army,
by
N. M. Marshall, C. E.
February, 1880.

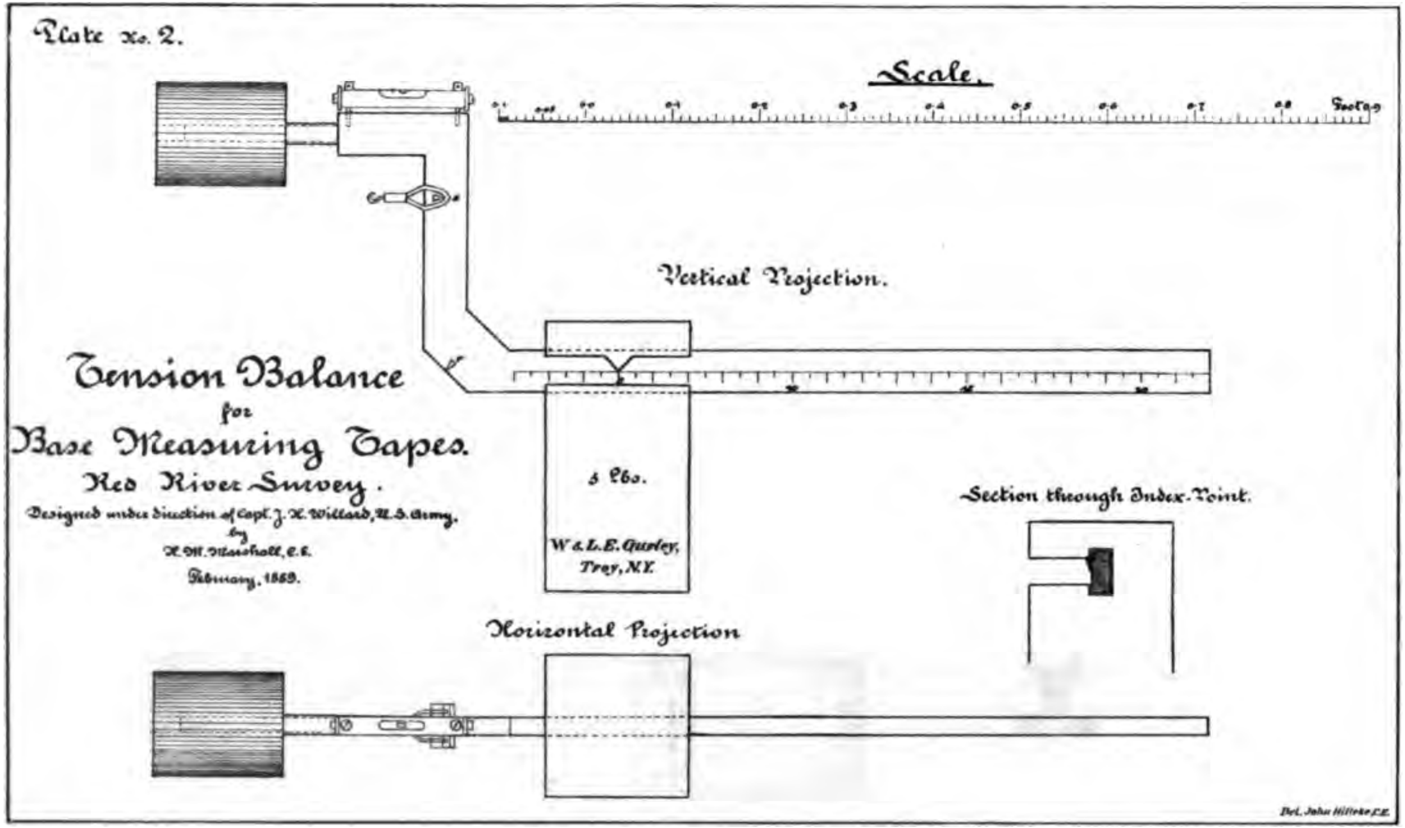
Scale.

Del. John Miller, C.E.

Photo-Lith. by A. Hoen & Co., Balto., Md.

Eng 93

Plate No. 2.



# Tension Balance
for
# Base Measuring Tapes.
## Red River Survey.

Designed under direction of Capt. J. H. Willard, U.S. Army,
by
R. M. Marshall, C.E.
February, 1869.

Del. John Hilleke C.E.

Photo-Lith. by A. Hoen & Co., Balto., Md.

Eng 93

# Vernier
for
## Brass and Steel Measuring Tapes.

Designed for use on
Red River Survey
under direction of Capt. J. H. Willard, U. S. Army.
by
X. M. Marshall, C. E.
February, 1889.

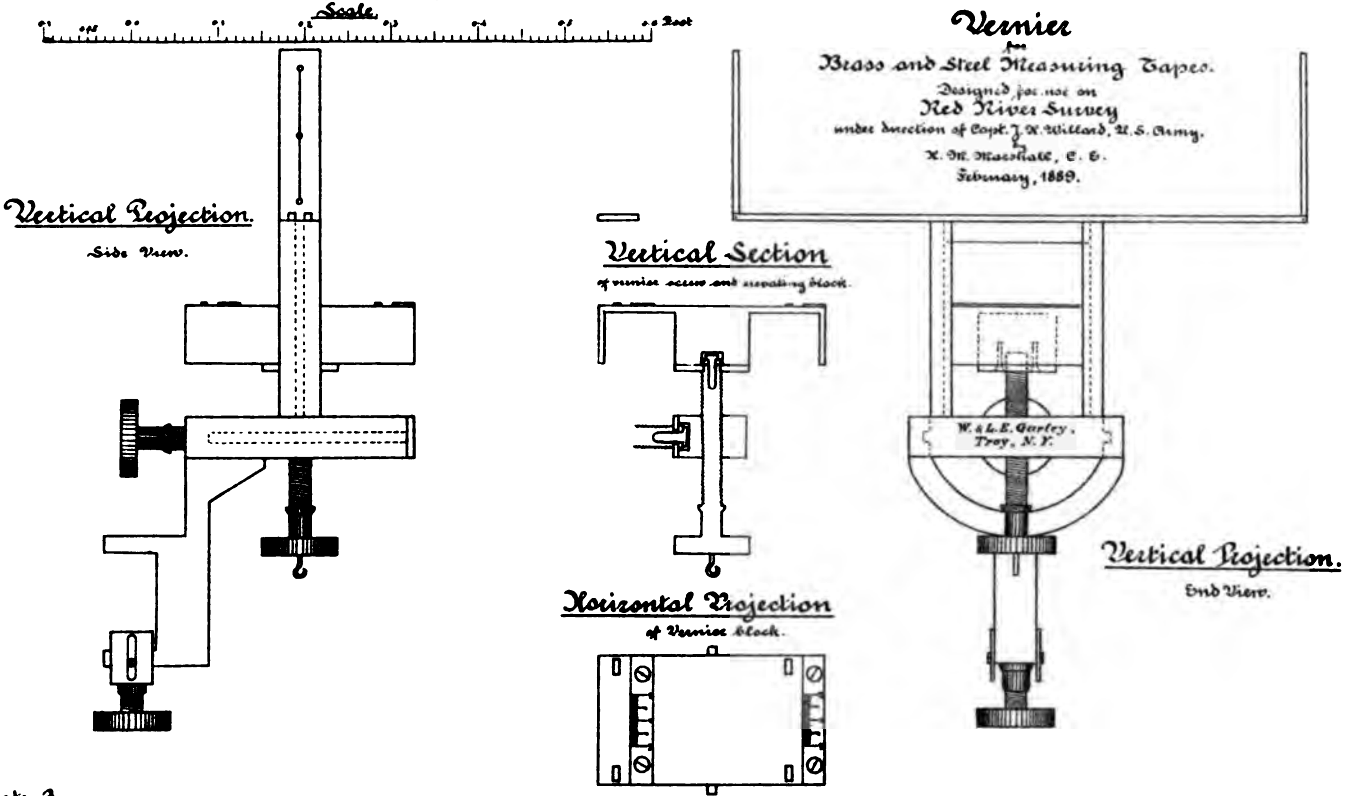


Plate 3.

Del. [illegible] C.E.

Photo-Lith. by A. Hoen & Co., Baltim., Md.

Verniers, shown in vertical projection, side and end views, also vertical section and horizontal projection of the vernier block, Plate 3, consist of a clamp and frame similar to the frame of the tension balance, with the addition of a hollow cast block. This block is attached to a slow-motion screw for raising it under the tapes after they are stretched, and is guided by flanges sliding in grooves in two vertical arms fastened to the other brass block, which is capable of transverse motion. The hollow cast block has on its upper face two metal graduated strips laid flat, with stops near the ends to hold the tapes close to the vernier. Verniers are marked 0 at the middle, and are set exactly opposite. The graduation extends 9 millimeters each way from the zeros, and is divided into ten parts, so that the reading is to a tenth of a millimeter. In the grooves of the vertical arms slips a flange fastened to a bar carrying folding compass sights, which enables the vernier zeros to be brought at right angles to the base line. In the center of the head of vertical slow-motion screw is a small hook for attaching a plumb bob.

4. Tape clamps.

There are four clamps an inch long, made so as to permit the tape to be slipped in on one side and held by a bearing plate pressed by two milled-head set screws, giving a straight pull in aligning, and having a swivel hook at one end.

5. Tape chains.

There are four chains about a meter long, made of No. 12 steel wire links about half an inch long.

6. Tape supports.

There are nine suspension supports, made of No. 12 wire, shaped like two sides of an isosceles triangle, whose height is 3 and base 2 inches, with a ring turned at the apex and having an extended hook with flat bottom at the end of each leg; the support is flat—that is, wire is all in the same plane.

Dimensions of instruments and lumber are given in feet and parts of a foot, rather than in the metric system, to conform to the customary measure of makers and mills.

To measure the base, the line is cleared, and six stakes 3 feet long, 2 inches square; three pieces of plank, 1¼ inches thick, 2 inches wide, and 2 feet long; nine stakes 2 inches square and of lengths somewhat to compensate irregularities of the ground line, are distributed over each tape length; stakes are all lined by transit. Beginning at the rear end of the tape, two stakes are driven about 3 feet back of the initial point of the base. On top is nailed a piece of the plank which makes a table to clamp tension frames to, one on each side. Two stakes are next driven level with the first two stakes, but 2 inches to the right of the line, about 9 inches forward and back of the initial point of the base. On these is nailed a plank for clamping vernier. Along the line, at intervals of one-tenth the tape length, stakes are set, with nails driven in the rear face of the stake, the heads being a little lower than the points; the nails are kept about level by the eye. At the front end of tape stakes are set for tables, as at the rear end, and in addition a table is set on line about 3 feet forward of the end of the tape and 2¼ inches lower than the vernier table, for clamping the tension frames of the balance beams. Elevations are taken on the vernier and heads of nails with a level. An observer, a recorder, and one assistant at each end of the tapes, and nine men at intervals of one-tenth the tape length, place the tapes one on each side of the stakes supported by the suspension hooks hung on the nails. The assistants adjust the clamps near the tape ends and hook on the chains, clamp the tension frames to the straining tables, one on each side, and by means of the chains attach the rear ends of the tapes to the frames and the front ends to the hooks on the balance beams, rest the beams on the knife edges, and slip the pea on the beam and set it to the required pull; adjust the tension by the slow-motion screws of the frames till the beam is balanced and the level centered. The observers clamp a vernier to the table at each end of the tape. At the rear it is set by the plumb over the initial point, aligning by the compass sights, raised under the tapes by the elevating screws, and adjusted by the transverse screws till the tapes lie easily alongside the verniers. With pocket rule rear observer measures height of vernier above table. Observer at front end cries, "Ready! read steel!" Both read the distance in millimeters on the tape from its zero to vernier zero and tenths of a milimeter on vernier and have recorders make entry. Observer at rear end replies, "Read!" Observer at front end cries, "Read brass!" Both read as before and observer at rear end replies, "Read!" Front observer cries, "Shift tapes forward!" and assistants by means of the slow-motion screws move the tapes bodily several centimeters along their length, the men at intermediate stakes being careful to keep supporting hooks swinging free by tapping them lightly. Front observer again cries, "Ready!" and the programme is repeated. The tapes are then shifted back beyond the initial reading and readings taken again.

In the reduction the mean of all the readings for each tape is taken to obtain the distance between vernier zeros.

For the next tape length the front observer calls out, "Make ready!" assistant at front end lifts balance beams and slips off the peas, both assistants unhook chains and unclamp tension frames, men along the line lift tapes and suspension hooks, rear observer unclamps vernier and sends it forward by his recorder to front recorder, front observer *leaves his vernier clamped* and calls, "Forward, march!" The remaining part of the base is measured in the same way, except that after moving forward the rear observer does not change the position of his vernier, unless he may have to alter the elevation by the elevating screw. In reading and recording *forward* is counted from tape zero in the direction the base is measured. At the front end of the tape *forward* readings are *plus* and *backward* readings are *minus*. At the rear end *forward* readings are *minus* and *backward* readings are *plus*. The check on readings in the field is that the *first* reading at *front* end *minus second* reading at *front* end must be nearly equal (within half a millimeter) the *first* reading at *rear* end *minus second* reading at *rear* end, and must be of *opposite sign;* in other words, after the tapes are shifted the shift must show the same amount and of *opposite* sign at the two ends of the tape, otherwise the readings were wrong.

### GENERAL FORMULAS DEVELOPED IN DETERMINING ABSOLUTE LENGTH OF STEEL TAPE, BASES, AND TEMPERATURE FROM TAPES USED SIDE BY SIDE.

Let $s_1$, $s_2$, $s_n$=mean vernier readings, front end, steel tape.
$s^1_1$, $s^1_2$, $s^1_n$=mean vernier readings, rear end, steel tape.
L=length of tape at 60° F.
$e$=coefficient of expansion of steel tape.
$d_1$, $d_2$, $d_n$=absolute distances between verniers.
$T_1$, $T_2$, $T_n$=temperature, Fahrenheit, at time of measurement.

Then, $L+e\,(T_1-60°)\,L=$ length of tape at time of measurement and $\Sigma d=B$ the length of base.

$$L+e\,(T_1-60°)\,L+[(s_1+s^1_1)+e\,(T_1-60°)\,(s_1+s^1_1)]=d_1.$$

Hence,

$$L+e\,(T_1-60°)\,L=d_1-[1+e\,(T_1-60°)]\,(s_1+s^1_1).$$

Also,

$$L+e\,(T_2-60°)\,L=d_2-[1+e\,(T_2-60°)]\,(s_2+s^1_2).$$

. . . . . . . . . . .

$$L+e\,(T_n-60°)\,L=d_n-[1+e\,(T_n-60°)]\,(s_n+s'_n).$$

$$L=\frac{B-[1+e\,(T_1-60°)](s_1+s^1_1)-[1+e\,(T_2-60°)](s_2+s^1_2)\;\ldots\;-[1+e\,(T_n-60°)](s_n+s^1_n)}{n+e[(T_1-60°)+(T_2-60°)\;\ldots\;+(T_n-60°)]}$$

But $e=0.000006\pm$ and $T-60°$ has no digit higher than the tens place, and generally only in the units place; also $s+s^1$ has the first significant figure in second or third decimal place; hence the product, $e(T-60°)\,(s+s^1)$, will have the first significant figure not higher than the fifth or sixth decimal place and may be neglected, and the formula becomes

$$L=\frac{B-(s_1+s^1_1)-(s_2+s^1_2)\;\ldots\;-(s_n+s^1_n)}{n+e(t_1+t_2\;\ldots\;+t_n)}$$

where $T_1-60°=t_1$, $T_2-60°=t_2$, etc.

But correction for change in grade $c=\frac{\Sigma h^2}{2l}+\frac{\Sigma h^4}{8l^3}$ must be added to the length of the base, where $h$ is the difference in height of adjacent supports and $l$ the interval between supports.

Hence,

$$L=\frac{B+\frac{\Sigma h^2}{2l}+\frac{\Sigma h^4}{8l^3}-(s_1+s^1_1)-(s_2+s^1_2)\;\ldots\;-(s_n+s^1_n)}{n+e(t_1+t_2\;\ldots\;+t_n)}=\frac{B+\frac{\Sigma h^3}{2l}+\frac{\Sigma h^4}{8l^3}-\Sigma(s+s^1)}{n+e\Sigma t.}$$

When the length of the tape is known the length of the base is given by the following equation:

$$B=nL+e(t_1+t_2\;\ldots\;+t_n)L-\frac{\Sigma h^2}{2l}-\frac{\Sigma h^4}{8l^3}+(s_1+s^1_1)+(s_2+s^1_2)\;\ldots\;+(s_n+s^1_n)$$

$$=nL+eL\Sigma t-\frac{\Sigma h^2}{2l}-\frac{\Sigma h^4}{8l^3}+\Sigma(s+s^1)$$

When brass and steel tapes are both used, the lengths being known at 60° F.

Let $b_1$ . . . . $b_2$ . . . . $b_n$ = mean vernier readings, front end, brass tape.
$b'_1$ . . . . $b'_2$ $b'_n$ = mean vernier readings, rear end, brass tape.
$L_1$ = length of brass tape at 60° F.
$e_1$ = coefficient of expansion of brass tape.

$$L^1 + e_1 (T_1 - 60^\circ) L_1 + (b_1 + b'_1) = d_1 = L + e (T_1 - 60^\circ) L + (s_1 + s'_1)$$

$$e_1 t_1 L_1 - et_1 L = L - L_1 - (b_1 + b'_1) + (s_1 + s'_1)$$

$$t_1 = \frac{L - L_1 - (b_1 + b'_1) + (s_1 + s'_1)}{e_1 L_1 - eL}$$

$$\Sigma t = \frac{n (L - L_1) - \Sigma (b + b') + \Sigma (s + s')}{e_1 L_1 - eL}$$

When

$$L = L_1$$

$$\Sigma t = \frac{\Sigma (s + s') - \Sigma (b + b')}{(e_1 - e) L}$$

To obtain the true lengths of the tapes the base of the United States Coast and Geodetic Survey at Delta, La., was measured on three nights. The description was furnished this office in manuscript. This base was selected and measured by the United States Coast and Geodetic Survey by means of 6-meter contact slide-rods in 1878. Length of base between monuments is 2,716.6434 meters.

Southwest base is located in the southwest part of Delta, La., just across the Vicksburg, Shreveport and Pacific Railway track, and about 10 meters from the southeast side of the parish road. It is marked by a limestone monument 4 feet long, dressed to 14 by 14 inches at the top, with ½-inch hole, having leaded into it a copper bolt with a crosscut on it. The monument was set in concrete. Elevation 32.837 meters above Cairo datum. There is no underground mark. A range stone 3½ feet long, dressed to 6 by 6 inches at the top, with a ½-inch copper bolt, marked with a cross, let into it, stands 85.12 feet from southwest base in prolongation of the base line.

Northeast base is located three-fifths of a mile northeast of Delta, La., on a point formed by a bend in the river, and is nearly equidistant from two negro cabins, the last on the point. The base is marked in every respect like southwest base, with the exception that the range stone and its underground mark are in line *between* the bases and 54.96 feet from northeast base.

The following shows the field record at front and rear end of the steel tape on the night of April 9, 1889, for the first half dozen tape lengths:

*Delta Base.—Observations for standardizing steel tape.*

FRONT END.

[April 9, 1889. T. C. Thomas, observer; W. H. Polk, recorder. Thermometer No. 2. At 70 meters from rear end is U. S. Signal Service compared thermometer No. 791.]

| Tape No. | Reading. | | Thermometer No. 2. | Time. | Mean reading. | Remarks. |
|---|---|---|---|---|---|---|
| | +Forward. | —Backward. | | | | |
| | *mm.* | *mm.* | ° | *p. m.* | *mm.* | |
| 1 | 67.1 | ........ | 66.1 | 8.22 | +27.7 | |
| | 4.6 | ........ | 68.0 | | | |
| | 11.3 | ........ | 68.4 | | | |
| 2 | 39.1 | ........ | 66.8 | 8.40 | +41.2 | |
| | 32.0 | ........ | 66.9 | | | |
| | 52.5 | ........ | 66.5 | | | |
| 3 | 2.8 | ........ | 63.1 | 8.57 | +7.7 | |
| | 3.1 | ........ | 63.1 | | | |
| | 17.1 | ........ | 62.5 | | | |
| 4 | ........ | 1.3 | 60.2 | 9.23 | +0.6 | |
| | 1.5 | ........ | 58.2 | | | |
| | 1.5 | ........ | 58.1 | | | |
| 5 | 43.9 | ........ | 60.0 | 9.50 | +35.4 | |
| | 36.4 | ........ | 59.6 | | | |
| | 25.9 | ........ | 59.3 | | | |
| 6 | 49.7 | ........ | 57.8 | 10.04 | +58.8 | |
| | 59.5 | ........ | 57.7 | | | |
| | 67.2 | ........ | 57.7 | | | |

### REAR END.

[T. G. Rombauer, observer; C. H. Schermerhorn, recorder. Thermometer No. 1. At 30 meters from rear end is U. S. Signal Service compared thermometer No. 1522.]

| Tape No. | Reading. |  | Thermometer No. 1. | Time. | Mean reading. | Remarks. |
|---|---|---|---|---|---|---|
|  | —Forward. | +Backward. |  |  |  |  |
|  | *mm.* | *mm.* | ° | *p. m.* | *mm.* |  |
| 1 | 19.3 | .............. | 68.0 | .......... | +19.4 | Vernier 2⅞ inches above table. |
|  | .............. | 42.0 | 67.8 |  |  |  |
|  | .............. | 35.5 | 68.8 |  |  |  |
| 2 | 26.0 | .............. | 68.5 | .......... | —28.6 | Vernier 2¼ inches above table. |
|  | 20.0 | .............. | 68.8 |  |  |  |
|  | 39.8 | .............. | 68.8 |  |  |  |
| 3 | .............. | 8.8 | 64.3 | .......... | + 4.1 | Vernier 2¾ inches above table. |
|  | .............. | 8.7 | 64.8 |  |  |  |
|  | 5.3 | .............. | 64.9 |  |  |  |
| 4 | 14.1 | .............. | 63.3 | .......... | —14.1 | Vernier 2¼ inches above table. |
|  | 14.1 | .............. | 62.1 |  |  |  |
|  | 14.2 | .............. | 62.8 |  |  |  |
| 5 | 9.3 | .............. | 61.0 | .......... | — 0.8 | Vernier 2¾ inches above table. |
|  | 1.8 | .............. | 60.9 |  |  |  |
|  | .............. | 8.7 | 60.8 |  |  |  |
| 6 | 14.3 | .............. | 59.0 | .......... | —22.8 | Vernier 2¼ inches above table. |
|  | 23.5 | .............. | 59.0 |  |  |  |
|  | 30.7 | .............. | 58.9 |  |  |  |

Table following gives the reduction from complete field record, of which preceding were a part. Thermometer readings have been corrected from error sheet.

### *Delta Base.—April 9, 1889.*

| Tape No. | Steel tape. |  |  |  | Thermometer. |  |  | T—60° | Grade correction. |  |
|---|---|---|---|---|---|---|---|---|---|---|
|  | Mean reading. |  | $s. + s^1$. |  | No. 1522. | No. 791. | Mean |  | $\Sigma h^2$ | $\Sigma h^4$ |
|  | $s$ | $s^1$ | + | — |  |  |  |  |  |  |
| 1 | +0.0277 | +0.0194 | 0.0471 | ......... | 67.6 | 66.8 | 67.2 | +7.2 | 0.1121 | 0.0125 |
| 2 | +0.0412 | —0.0286 | 0.0126 | ......... | 68.4 | 66.0 | 67.2 | +7.2 | 0.2608 | 0.0681 |
| 3 | +0.0077 | +0.0041 | 0.0118 | ......... | 64.1 | 62.2 | 63.1 | +3.1 | 0.0342 | 0.0011 |
| 4 | +0.0006 | —0.0141 | ......... | 0.0135 | 62.3 | 58.1 | 60.2 | +0.2 | 0.2234 | 0.0497 |
| 5 | +0.0354 | —0.0008 | 0.0346 | ......... | 60.5 | 58.9 | 59.7 | —0.3 | 0.0346 | 0.0012 |
| 6 | +0.0588 | —0.0228 | 0.0360 | ......... | 58.6 | 57.0 | 57.8 | —2.2 | 0.4146 | 0.1722 |
| 7 | —0.0056 | —0.0022 | ......... | 0.0078 | 60.4 | 60.3 | 60.3 | +0.3 | 1.3187 | 1.7389 |
| 8 | —0.0155 | —0.0091 | ......... | 0.0246 | 59.5 | 58.4 | 58.9 | —1.1 | 0.0058 | ....... |
| 9 | +0.0689 | —0.0392 | 0.0297 | ......... | 59.7 | 59.3 | 59.5 | —0.5 | 0.0065 | ....... |
| 10 | +0.0203 | —0.0022 | 0.0181 | ......... | 59.8 | 60.9 | 60.3 | +0.3 | 0.0049 | ....... |
| 11 | +0.0272 | —0.0105 | 0.0167 | ......... | 60.3 | 59.5 | 59.9 | —0.1 | 0.0061 | ....... |
| 12 | +0.0222 | +0.0228 | 0.0450 | ......... | 59.2 | 58.9 | 59.0 | —1.0 | 0.0341 | 0.0011 |
| 13 | —0.0449 | +0.0074 | ......... | 0.0375 | 59.1 | 58.0 | 58.5 | —1.5 | 0.0077 | 0.0001 |
| 14 | +0.0101 | +0.0109 | 0.0210 | ......... | 59.6 | 59.7 | 59.6 | —0.4 | 0.0104 | 0.0001 |
| 15 | +0.0090 | +0.0095 | 0.0185 | ......... | 59.9 | 60.3 | 60.1 | +0.1 | 0.0139 | 0.0002 |
| 16 | +0.0142 | +0.0207 | 0.0349 | ......... | 62.4 | 61.4 | 61.9 | +1.9 | 0.0099 | 0.0001 |
| 17 | +0.0146 | —0.0103 | 0.0043 | ......... | 61.7 | 61.8 | 61.7 | +1.7 | 0.0043 | ....... |
| 18 | +0.0429 | —0.0337 | 0.0092 | ......... | 61.4 | 61.0 | 61.2 | +1.2 | 0.0102 | 0.0001 |
| 19 | +0.0475 | —0.0138 | 0.0337 | ......... | 60.7 | 59.9 | 60.3 | +0.3 | 0.0037 | ....... |
| 20 | +0.0100 | —0.0355 | ......... | 0.0255 | 59.9 | 59.9 | 59.9 | —0.1 | 0.0265 | 0.0007 |
| 21 | +0.0168 | —0.0061 | 0.0107 | ......... | 60.1 | 58.5 | 59.3 | —0.7 | 0.0032 | ....... |
| 22 | +0.0419 | —0.0419 | ......... | ......... | 58.3 | 58.5 | 58.4 | —1.6 | 0.0203 | 0.0004 |
| 23 | +0.0261 | —0.0066 | 0.0195 | ......... | 59.3 | 59.1 | 59.2 | —0.8 | 0.0708 | 0.0050 |
| 24 | +0.0518 | —0.0187 | 0.0331 | ......... | 58.5 | 60.0 | 59.2 | —0.8 | 0.0354 | 0.0012 |
| 25 | —0.0146 | —0.0104 | ......... | 0.0250 | 58.2 | 59.1 | 58.6 | —1.4 | 0.0038 | ....... |
| 26 | —0.0025 | —0.0070 | ......... | 0.0095 | 61.2 | 62.4 | 61.8 | +1.8 | 0.0049 | ....... |
| 27 | —0.0322 | —0.0234 | ......... | 0.0556 | 59.2 | 59.1 | 59.1 | —0.9 | 0.3911 | 0.1529 |
|  |  |  | 0.4365 | 0.1990 |  |  |  |  |  |  |
|  |  |  | +0.2375 |  |  |  |  | +11.9 | 3.0720 | 2.3056 |

The following are equations for length of tape from foregoing and from observations made in the same manner on the nights of April 10 and 11:

$$L = \frac{2716.6434 - 0.2375 + \frac{3.0720}{20.12} + \frac{2.3056}{8144.56}}{27 + 0.000006 \times 11.9}$$

$$L = \frac{2716.6434 - 0.1601 + \frac{3.0073}{20.12} + \frac{2.1555}{8144.56}}{27 + 0.000006 \times 138.7}$$

$$L = \frac{2716.6434 - 0.0707 + \frac{3.0819}{20.12} + \frac{2.1941}{8144.56}}{27 + 0.000006 \times 288.3}$$

Whence,

L = 100.61301 meters.
L = 100.61295 meters.
L = 100.61304 meters.
Mean L = 100.61300 meters.

The base at Lum Point, La., measured twice by U. S. Coast and Geodetic Survey in 1880, using 6-meter contact slide-rods, was measured by means of Red River survey base apparatus. A description of the base was furnished this office in manuscript by the Coast Survey Office. The line is located at Lum Point, on the opposite side of the river from Fort Adams, and about 3 miles below that base. Southwest base station is just back of Lum's house. Both ends of the base are marked alike by a stone monument, 3 feet 6 inches long, dressed to 14 inches square at the top, with a one-fourth inch hole, having leaded into it a copper bolt with a cross cut on it. The underground marks consist of an 8-inch cube, cut from limestone, with a hole and copper bolt in the top, with a cross cut on it directly under the triangulation station, 4 feet 6 inches under the surface of the earth. The mark is set in concrete, with a layer of earth 6 inches thick above it. The length of the base is 1921.823 meters between monuments. The base being incommensurable with the length of the tape, 3.750 meters were deducted by measuring back with Mississippi River Commission precise-level rod XII, and the remainder of the base was measured on the night of February 1, 1892. Table following give the reduction from the field record:

*Lum Point Base.—February 1, 1892.*

[Metric scale.]

| Tape No. | Steel tape. |  |  | Thermometer. |  |  | T—60° | Grade correction. |
|---|---|---|---|---|---|---|---|---|
|  | Mean reading. |  | s. + s¹ | No. 3236. | No. 1444. | Mean |  |  |
|  | s¹ | s | + |  |  |  |  | Σ h² |
| 1 | +0.1686 | +0.1695 | 0.3381 | 45.8 | 45.0 | 45.4 | —14.6 | 0.0031 |
| 2 | +0.1703 | +0.1715 | 0.3418 | 44.0 | 43.2 | 43.6 | —16.4 | 0.0066 |
| 3 | +0.1762 | +0.1735 | 0.3497 | 43.8 | 43.0 | 43.4 | —16.6 | 0.0030 |
| 4 | +0.1838 | +0.1513 | 0.3351 | 45.0 | 44.3 | 44.6 | —15.4 | 0.0023 |
| 5 | +0.1721 | +0.1691 | 0.3412 | 46.0 | 45.5 | 45.7 | —14.3 | 0.0028 |
| 6 | +0.1894 | +0.1714 | 0.3608 | 46.1 | 45.5 | 45.8 | —14.2 | 0.0012 |
| 7 | +0.1816 | +0.1711 | 0.3527 | 46.0 | 45.5 | 45.7 | —14.3 | 0.0011 |
| 8 | +0.1820 | +0.1736 | 0.3556 | 45.0 | 44.2 | 44.6 | —15.4 | 0.0018 |
| 9 | +0.1596 | +0.1723 | 0.3319 | 42.8 | 41.8 | 42.3 | —17.7 | 0.0011 |
| 10 | +0.1935 | +0.1686 | 0.3621 | 43.8 | 42.3 | 43.0 | —17.0 | 0.0046 |
| 11 | +0.1480 | +0.1825 | 0.3305 | 41.8 | 42.2 | 42.0 | —18.0 | 0.0016 |
| 12 | +0.1690 | +0.1763 | 0.3458 | 44.0 | 42.5 | 43.2 | —16.8 | 0.0007 |
| 13 | +0.1802 | +0.1773 | 0.3575 | 42.8 | 42.0 | 42.4 | —17.6 | 0.0113 |
| 14 | +0.1723 | +0.1794 | 0.3517 | 42.3 | 41.0 | 41.6 | —18.4 | 0.0020 |
| 15 | +0.1985 | +0.1942 | 0.3927 | 42.8 | 42.0 | 42.4 | —17.6 | 0.0106 |
| 16 | +0.1745 | +0.1783 | 0.3528 | 43.3 | 41.8 | 42.5 | —17.5 | 0.0015 |
| 17 | +0.1658 | +0.1848 | 0.3506 | 43.0 | 42.0 | 42.5 | —17.5 | 0.0029 |
| 18 | +0.1656 | +0.1750 | 0.3415 | 42.5 | 42.0 | 42.2 | —17.8 | 0.0022 |
| 19 | +0.1455 | +0.1815 | 0.3270 | 42.8 | 42.0 | 42.4 | —17.6 | 0.0070 |
|  |  |  | 6.6186 |  |  |  | 314.7 | 0.0674 |

$$L = \frac{1918.073 - 6.6186 + \frac{0.0674}{20}}{19 - 0.000006 \times 314.7}$$

Whence,

L = 100.61304 meters.

On the night of February 2, 1892, the base was measured in like manner, 3.748 meters being deducted and 100.61185 meters obtained as the length of the tape. This value is rejected because it is so widely apart from the three measurements at the Delta base and those taken at Lum Point base, that it is evident a mistake was made though it can not be detected in the record.

On the night of February 3, the base was extended by measuring 5 tape lengths, using the tape as short as possible, *i. e.*, by making all the vernier readings minus; thereby making the base and extension commensurable with the tape length used as long as possible, *i. e.*, making all the vernier readings plus. The following tables give the measurements as made forward and back:

### *Extension, Lum Point Base.—February 3, 1892.*

#### FIRST MEASUREMENT.

| Tape No. | Steel tape. | | | Thermometer. | | | T—60° | Grade correction. | |
|---|---|---|---|---|---|---|---|---|---|
| | Mean reading. | | $s+s^1$ | No. 3236. | No. 1444. | Mean. | | $\Sigma h^2$ | $\Sigma h^4$ |
| | $s$ | $s^1$ | — | | | | | | |
| 1 | —0.1891 | —0.1605 | 0.3496 | 48.9 | 48.5 | 48.7 | —11.3 | 0.0018 | Insignificant. |
| 2 | —0.1753 | —0.1578 | 0.3331 | 48.0 | 46.8 | 47.4 | —12.6 | 0.0005 | |
| 3 | —0.1935 | —0.1710 | 0.3645 | 47.2 | 47.1 | 47.1 | —12.9 | 0.0045 | |
| 4* | —0.2046 | —0.1941 | 0.3987 | 47.0 | 46.0 | 46.5 | —13.5 | 0.0026 | |
| 5 | —0.1168 | —0.1554 | 0.2722 | 47.1 | 46.1 | 46.6 | —13.4 | 0.0020 | |
| | | | 1.7181 | | | | 63.7 | 0.0114 | |

Extension = 5 L — 0.000006 L 63.7 — 1.7181 — 0.00057 = 4.9996178 L — 1.71867.

#### SECOND MEASUREMENT.

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1 | —0.1854 | —0.1929 | 0.3783 | 55.9 | 54.3 | 55.1 | — 4.9 | 0.0018 | |
| 2 | —0.1888 | —0.1881 | 0.3760 | 49.7 | 49.4 | 49.5 | —10.5 | 0.0005 | |
| 3* | —0.2044 | —0.1903 | 0.3947 | 51.4 | 49.7 | 50.5 | — 9.5 | 0.0045 | |
| 4 | —0.1170 | —0.1756 | 0.2926 | 47.2 | 46.4 | 46.8 | —13.2 | 0.0026 | |
| 5 | —0.1252 | —0.1627 | 0.2879 | 48.7 | 47.7 | 48.2 | —11.8 | 0.0020 | |
| | | | 1.7304 | | | | 49.9 | 0.0114 | |

* Excess over 0.200 read on the vernier between vernier zero and the backward graduation on the tape and reduced by a tenth part.

Extension = 5 L — 0.000006 L 49.9 — 1.7304 — 0.00057 = 4.9997006 L — 1.73097.
Mean of two measurements = 4.9996592 L — 1.72482.

By this extension the base became 1920.09818 + 4.9996592 L and the equation for tape length—

$$L = \frac{1920.09818 - \Sigma\,(s + s^1) + \dfrac{\Sigma h^2}{2l}}{19.0003408 + 0.000006t}$$

The base and extension were measured as one on the nights of the 4th and 5th and the results reduced in the usual manner gave—

$$L = \frac{1920.09818 - 8.3880 + 0.00337}{19.0003408 + 0.000006 \times 25.1}$$

and

$$L = \frac{1920.09818 - 8.5087 + 0.00337}{19.0003408 - 0.000006 \times 127.2}$$

whence L = 100.61390 and L = 100.61238 which with the measurement on the 1st gave for a mean L = 100.61310. This exceeds the length as determined at Delta by 0.1 millimeter, or one millionth part of the tape length. When the tape was standardized at Delta paper scales were glued on as stated, the zeros being marked by knife cuts, and these were referenced by other knife marks one meter distance when the tape was copper plated; it is therefore not to be wondered at if the actual change in length of the tape, the difference in measurement of the two bases by the Coast Survey, and the error in measuring the two bases by means of the tape sums up 0.1 millimeter per tape length. The integrity of the three measurements of Delta base and of three of the measurements of Lum Point base is above suspicion, and the only cloud on a claim justified by the result is the one rejected measurement.

For practical purposes of the survey the difference did not justify the cost of remeasuring the Delta base.

The following results were obtained by comparing brass and steel tapes stretched side by side under 16 pounds tension and supported as in measuring a base. Omitted readings rejected in the field, except Nos. 2, 7, 8, 12, and 13, taken May 27, 1889, which were rejected in the office:

*Comparison of brass and steel tapes.*

[Metric scale.]

| Date. | Tape No. | Steel tape. |  |  | Brass tape. |  |  | Thermometer. |  |  | T-60° F. |
|---|---|---|---|---|---|---|---|---|---|---|---|
|  |  | Reading. |  | $s+s^1$ | Reading. |  | $b+b^1$ | No. 1522. | No. 791. | Mean. |  |
|  |  | $s$ | $s^1$ |  | $b$ | $b^1$ |  |  |  |  |  |
| 1889. |  |  |  |  |  |  |  |  |  |  |  |
| May 8 | 5 | −0.0137 | −0.0048 | −0.0185 | +0.0063 | −0.0051 | +0.0012 | 75.6 | 76.1 | 75.8 | +15.8 |
|  | 6 | −0.0132 | −0.0048 | −0.0180 | +0.0070 | −0.0051 | +0.0019 | 74.8 | 75.3 | 75.0 | +15.0 |
|  | 7 | −0.0123 | −0.0048 | −0.0171 | +0.0084 | −0.0051 | +0.0033 | 72.6 | 73.1 | 72.8 | +12.8 |
|  | 8 | −0.0119 | −0.0048 | −0.0167 | +0.0090 | −0.0051 | +0.0039 | 72.2 | 72.0 | 72.1 | +12.1 |
|  | 9 | −0.0104 | −0.0048 | −0.0152 | +0.0114 | −0.0051 | +0.0063 | 71.4 | 70.1 | 70.7 | +10.7 |
|  | 10 | −0.0101 | −0.0048 | −0.0149 | +0.0120 | −0.0051 | +0.0069 | 70.9 | 68.1 | 69.5 | + 9.5 |
|  | 12 | −0.0096 | −0.0047 | −0.0143 | +0.0125 | −0.0046 | +0.0079 | 69.6 | 68.9 | 69.2 | + 9.2 |
| May 25* | 8 | +0.0057 | −0.0233 | −0.0176 | +0.0795 | −0.0802 | −0.0007 | 78.5 | 79.6 | 79.0 | +19.0 |
|  | 9 | +0.0157 | −0.0336 | −0.0179 | +0.0679 | −0.0906 | −0.0027 | 78.5 | 79.2 | 78.8 | +18.8 |
|  | 10 | +0.0088 | −0.0264 | −0.0176 | +0.0812 | −0.0825 | −0.0013 | 78.2 | 79.3 | 78.7 | +18.7 |
|  | 11 | −0.0017 | −0.0160 | −0.0177 | +0.0712 | −0.0747 | −0.0035 | 78.5 | 79.3 | 78.9 | +18.9 |
|  | 12 | −0.0140 | −0.0040 | −0.0180 | +0.0637 | −0.0670 | −0.0033 | 78.3 | 79.2 | 78.7 | +18.7 |
|  | 13 | −0.0235 | +0.0058 | −0.0177 | +0.0575 | −0.0605 | −0.0030 | 78.3 | 79.2 | 78.7 | +18.7 |
|  | 14 | −0.0312 | +0.0137 | −0.0175 | +0.0523 | −0.0555 | −0.0032 | 78.2 | 79.1 | 78.6 | +18.6 |
|  | 15 | −0.0474 | +0.0296 | −0.0178 | +0.0449 | −0.0464 | −0.0015 | 78.0 | 79.1 | 78.5 | +18.5 |
| May 27 (a. m.) | 2 | −0.0811 | +0.0303 | −0.0508 | −0.0071 | −0.0290 | −0.0361 | 85.3 | 84.1 | 84.7 | +24.7 |
|  | 3 | −0.0811 | +0.0303 | −0.0508 | −0.0071 | −0.0288 | −0.0359 | 87.2 | 83.1 | 85.1 | +25.1 |
|  | 4 | −0.0825 | +0.0303 | −0.0522 | −0.0078 | −0.0288 | −0.0366 | 87.7 | 81.1 | 84.4 | +24.4 |
|  | 5 | −0.0826 | +0.0303 | −0.0523 | −0.0083 | −0.0288 | −0.0371 | 89.6 | 80.3 | 84.9 | +24.9 |
|  | 6 | −0.0827 | +0.0303 | −0.0524 | −0.0083 | −0.0288 | −0.0371 | 90.7 | 81.1 | 85.9 | +25.9 |
|  | 7 | −0.0831 | +0.0303 | −0.0528 | −0.0090 | −0.0288 | −0.0378 | 89.0 | 81.9 | 85.4 | +25.4 |
|  | 8 | −0.0821 | +0.0305 | −0.0516 | −0.0091 | −0.0287 | −0.0378 | 88.0 | 83.0 | 85.5 | +25.5 |
|  | 9 | −0.0832 | +0.0303 | −0.0529 | −0.0090 | −0.0288 | −0.0378 | 87.8 | 83.2 | 85.5 | +25.5 |
|  | 10 | −0.0835 | +0.0304 | −0.0531 | −0.0096 | −0.0288 | −0.0384 | 90.4 | 84.2 | 87.3 | +27.3 |
|  | 11 | −0.0839 | +0.0304 | −0.0535 | −0.0099 | −0.0288 | −0.0387 | 91.5 | 85.4 | 88.4 | +28.4 |
| May 27* (p. m.) | 1 | −0.0829 | +0.0304 | −0.0525 | −0.0099 | −0.0288 | −0.0387 | 88.3 | 85.2 | 86.7 | +26.7 |
|  | 3 | −0.0715 | +0.0175 | −0.0540 | −0.0045 | −0.0367 | −0.0412 | 88.5 | 85.1 | 86.8 | +26.8 |
|  | 4 | −0.0604 | +0.0060 | −0.0544 | +0.0031 | −0.0446 | −0.0415 | 88.5 | 86.2 | 87.3 | +27.3 |
|  | 5 | −0.0680 | +0.0141 | −0.0539 | −0.0060 | −0.0332 | −0.0392 | 89.0 | 87.1 | 88.0 | +28.0 |
|  | 6 | −0.0761 | +0.0218 | −0.0543 | −0.0181 | −0.0215 | −0.0396 | 91.5 | 85.1 | 88.3 | +28.3 |
|  | 9 | −0.0825 | +0.0283 | −0.0542 | −0.0421 | +0.0004 | −0.0417 | 89.7 | 86.0 | 87.8 | +27.8 |
|  | 10 | −0.0880 | +0.0337 | −0.0543 | −0.0452 | +0.0045 | −0.0407 | 89.2 | 85.1 | 87.1 | +27.1 |
|  | 11 | −0.0935 | +0.0387 | −0.0548 | −0.0509 | +0.0094 | −0.0415 | 87.5 | 84.3 | 85.9 | +25.9 |
| 1892. |  |  |  |  |  |  |  | No. 8236 | No. 1444 |  |  |
| Feb. 1 | 1 | +0.1849 | −0.0070 | +0.1779 | +0.0632 | +0.1508 | +0.2140 | 41.8 | 40.5 | 41.1 | −18.9 |
|  | 2 | +0.1870 | −0.0090 | +0.1780 | +0.0649 | +0.1487 | +0.2136 | 41.8 | 41.0 | 41.4 | −18.6 |
|  | 3 | +0.1922 | −0.0145 | +0.1777 | +0.0702 | +0.1434 | +0.2136 | 41.8 | 41.0 | 41.4 | −18.6 |
|  | 4 | +0.1953 | −0.0174 | +0.1779 | +0.0731 | +0.1406 | +0.2137 | 41.8 | 41.0 | 41.4 | −18.6 |
|  | 5 | +0.1920 | −0.0134 | +0.1786 | +0.0708 | +0.1445 | +0.2148 | 40.8 | 41.0 | 40.9 | −19.1 |
|  | 6 | +0.1842 | −0.0054 | +0.1788 | +0.0631 | +0.1525 | +0.2156 | 41.3 | 40.5 | 40.9 | −19.1 |
|  | 7 | +0.1789 | +0.0001 | +0.1790 | +0.0576 | +0.1578 | +0.2154 | 41.3 | 40.0 | 40.6 | −19.4 |
|  | 8 | +0.1721 | +0.0054 | +0.1775 | +0.0525 | +0.1632 | +0.2157 | 40.8 | 40.0 | 40.4 | −19.6 |
|  | 9 | +0.1541 | +0.0214 | +0.1755 | +0.0370 | +0.1792 | +0.2162 | 40.8 | 40.5 | 40.6 | −19.4 |
|  | 10 | +0.1425 | +0.0332 | +0.1757 | +0.0255 | +0.1908 | +0.2163 | 41.3 | 40.5 | 40.9 | −19.1 |
| Feb. 2 | 1 | +0.1133 | +0.0094 | +0.1227 | +0.0538 | +0.1017 | +0.1555 | 44.8 | 44.5 | 44.6 | −15.4 |
|  | 2 | +0.1066 | +0.0163 | +0.1228 | +0.0469 | +0.1086 | +0.1555 | 44.8 | 44.5 | 44.6 | −15.4 |
|  | 3 | +0.0990 | +0.0237 | +0.1227 | +0.0398 | +0.1160 | +0.1558 | 44.8 | 44.5 | 44.6 | −15.4 |
|  | 4 | +0.0933 | +0.0297 | +0.1230 | +0.0340 | +0.1222 | +0.1562 | 44.8 | 44.5 | 44.6 | −15.4 |
|  | 5 | +0.0885 | +0.0342 | +0.1227 | +0.0294 | +0.1266 | +0.1560 | 44.8 | 44.5 | 44.6 | −15.4 |
|  | 6 | +0.0846 | +0.0384 | +0.1230 | +0.0255 | +0.1308 | +0.1563 | 44.8 | 44.5 | 44.6 | −15.4 |
|  | 7 | +0.0902 | +0.0321 | +0.1223 | +0.0295 | +0.1246 | +0.1541 | 44.8 | 44.5 | 44.6 | −15.4 |
|  | 8 | +0.0942 | +0.0280 | +0.1222 | +0.0335 | +0.1203 | +0.1538 | 44.8 | 44.0 | 44.4 | −15.6 |

* Tapes shifted forward and back in this set.

The result of each observation being written in the general form

$$t=\frac{L-L_1-(b+b^1)+(s+s^1)}{e_1L_1-eL}, \text{ or } t\,(L_1e_1-Le)=L-L_1+[(s+s^1)-(b+b^1)]$$

putting $y=(s+s^1)-(b+b^1)$ $x=t$ $a=L_1e_1-Le$ $c=L-L_1$

the equation becomes $ax=c+y$.

When $x$ and $y$ are taken as the mean of all the observations,

$$c=ax_0-y_0$$

and taking the difference between the mean and each observation,

$$a\,(x-x_0)-(y-y_0)=0.$$

By multiplying through by $(x-x_0)$, that is, giving each observation weight according to its range in temperature,

$$a\,(x-x_0)^2-(x-x_0)\,(y-y_0)=0.$$

Summing the results of all observations,

$$a\Sigma\,(x-x_0)^2-\Sigma\,(x-x_0)\,(y-y_0)=0$$

$$a=\frac{\Sigma\,(x-x_0)\,(y-y_0)}{\Sigma\,(x-x_0)^2}$$

In the fifty-one observations, $y_0=-0.02275$, $x_0=+7.8$, from the reduction shown in the following table,

$$a=\frac{9.29219}{18877.16}=+0.0004922$$

the change in relative lengths of tapes for each degree alteration of temperature. Hence

$$e_1-e=0.000004892 \quad c=7.8+0.0004922+0.02275=0.026609.$$

At 0° F. $L=L_1+0.056141$; at 60° F. $L=L_1+0.026609$; at 114° F. $L=L_1$

*Computation: Comparison of brass and steel tapes.*

[Metric scales.]

| Tape No. | $(s+s^1)-(b+b^1)$<br>$y$ | $y-y_0$ | $x-x_0$ | $(x-x_0)^2$ | $(x-x_0)\,(y-y_0)$<br>+ |
|---|---|---|---|---|---|
| 5 | −0.0197 | +0.00305 | + 8.0 | 64.00 | 0.024400 |
| 6 | −0.0199 | +0.00285 | + 7.2 | 51.84 | 0.020520 |
| 7 | −0.0204 | +0.00235 | + 5.0 | 25.00 | 0.011750 |
| 8 | −0.0206 | +0.00215 | + 4.3 | 18.49 | 0.009245 |
| 9 | −0.0215 | +0.00125 | + 2.9 | 8.41 | 0.003625 |
| 10 | −0.0218 | +0.00095 | + 1.7 | 2.89 | 0.001615 |
| 12 | −0.0222 | +0.00055 | + 1.4 | 1.96 | 0.000770 |
| 8 | −0.0169 | +0.00585 | +11.2 | 125.44 | 0.065520 |
| 9 | −0.0152 | +0.00755 | +11.0 | 121.00 | 0.083050 |
| 10 | −0.0163 | +0.00645 | +10.9 | 118.81 | 0.070305 |
| 11 | −0.0142 | +0.00855 | +10.1 | 102.01 | 0.086355 |
| 12 | −0.0147 | +0.00805 | +10.9 | 118.81 | 0.087745 |
| 13 | −0.0147 | +0.00805 | +10.9 | 118.81 | 0.087745 |
| 14 | −0.0143 | +0.00845 | +10.8 | 116.64 | 0.091260 |
| 15 | −0.0163 | +0.00645 | +10.7 | 114.49 | 0.069015 |
| 2 | −0.0147 | +0.00805 | +16.9 | 285.61 | 0.136045 |
| 3 | −0.0149 | +0.00785 | +17.3 | 299.29 | 0.135805 |
| 4 | −0.0156 | +0.00715 | +16.6 | 275.56 | 0.118690 |
| 5 | −0.0152 | +0.00755 | +17.1 | 292.41 | 0.129105 |
| 6 | −0.0153 | +0.00745 | +18.1 | 327.61 | 0.134845 |
| 7 | −0.0150 | +0.00775 | +17.6 | 309.76 | 0.136400 |
| 8 | −0.0138 | +0.00895 | +17.7 | 313.29 | 0.158415 |
| 9 | −0.0151 | +0.00765 | +17.7 | 313.29 | 0.135405 |
| 10 | −0.0147 | +0.00805 | +19.5 | 380.25 | 0.156975 |
| 11 | −0.0148 | +0.00795 | +20.6 | 424.36 | 0.163770 |
| 1 | −0.0138 | +0.00895 | +18.9 | 357.21 | 0.169155 |
| 3 | −0.0128 | +0.00995 | +19.0 | 361.00 | 0.189050 |
| 4 | −0.0129 | +0.00985 | +19.5 | 380.25 | 0.192075 |
| 5 | −0.0147 | +0.00805 | +20.2 | 408.04 | 0.162610 |
| 6 | −0.0147 | +0.00805 | +20.5 | 420.25 | 0.165025 |
| 9 | −0.0125 | +0.01025 | +20.0 | 400.00 | 0.205000 |
| 10 | −0.0136 | +0.00915 | +19.3 | 372.49 | 0.176595 |

*Computation: Comparison of brass and steel tapes*—Continued.

[Metric scales.]

| Tape No. | $(s+s')-(b+b')$<br>$y$ | $y-y_0$ | $x-x_0$ | $(x-x_0)^2$ | $(x-x_0)(y-y_0)$<br>+ |
|---|---|---|---|---|---|
| 11 | −0. 0133 | +0. 00945 | +18. 1 | 327. 61 | 0. 171045 |
| 1 | −0. 0361 | −0. 01335 | −26. 7 | 712. 89 | 0. 356445 |
| 2 | −0. 0356 | −0. 01285 | −26. 4 | 696. 96 | 0. 339240 |
| 3 | −0, 0359 | −0. 01315 | −26. 4 | 696. 96 | 0. 347160 |
| 4 | −0. 0358 | −0. 01305 | −26. 4 | 696. 96 | 0. 344520 |
| 5 | −0. 0362 | −0. 01345 | −26. 9 | 723. 61 | 0. 361805 |
| 6 | −0. 0368 | −0. 01405 | −26. 9 | 723. 61 | 0. 377945 |
| 7 | −0. 0364 | −0. 01365 | −27. 2 | 739. 84 | 0. 371280 |
| 8 | −0. 0382 | −0. 01545 | −27. 4 | 750. 76 | 0. 423330 |
| 9 | −0. 0407 | −0. 01795 | −27. 2 | 739. 84 | 0. 488240 |
| 10 | −0. 0406 | −0. 01785 | −26. 9 | 723. 61 | 0. 480165 |
| 1 | −0. 0328 | −0. 01005 | −23. 2 | 538. 24 | 0. 233160 |
| 2 | −0. 0327 | −0. 00995 | −23. 2 | 538. 24 | 0. 230840 |
| 3 | −0. 0331 | −0. 01035 | −23. 2 | 538. 24 | 0. 240120 |
| 4 | −0. 0332 | −0. 01045 | −23. 2 | 538. 24 | 0. 242440 |
| 5 | −0. 0333 | −0. 01055 | −23. 2 | 538. 24 | 0. 244760 |
| 6 | −0. 0333 | −0. 01055 | −23. 2 | 538. 24 | 0. 244760 |
| 7 | −0. 0318 | −0. 00905 | −23. 2 | 538. 24 | 0. 209960 |
| 8 | −0. 0316 | −0. 00885 | −23. 4 | 547. 56 | 0. 207090 |
|  | 51)−1. 1602<br>−0. 02275 |  |  | 18877. 16 | 9. 29219 |

## TRIANGULATION.

The triangulation has been carried from Shreveport to Lum Point by a system of single triangles, with sides varying from 400 to 4,000 meters, and averaging 800 meters, divided into nine stretches by ten bases, two of whose lengths were obtained by measurement with the base apparatus, one from the Coast Survey and the others by measurement with a small compared tape, and the azimuths determined by observation of a circumpolar star near elongation. The discrepancy between measured and calculated lengths of bases at Black River and Lum Point was so great that a party was sent to measure intermediate bases. The stretch between Barbin Landing and Black River, which had been covered by 50 triangles, was divided by two bases into three stretches, and between the latter place and Lum Point, which had been embraced by 56 triangles, four bases were interpolated. While this multiplication of bases increased the accuracy of the triangulation to only a moderate extent, they prove the absence of any accidental errors and reveal the existence of a persistent source of error. Between Barbin and Bayou Cocodrie the discrepancy on bases is always in the same direction, and, except at Red Light Landing, is approximately proportional to the number of triangles between. The region is densely wooded, with a few small isolated clearings, and in order to save cutting on the lines between stations, without reducing the size of the triangles, as often as practicable a station was placed on the bank of the river. In this manner one side of a triangle might pass its entire length through the open space above the river, while the other sides passed in part across the river and in part through the opening cut in the timber. In cases where the stations stood back from the river bank two lines in each triangle crossed the river from the timber and into the timber again. It is suggested by Assistant Engineer T. C. Thomas, who has conducted the triangulation from the beginning, that the error is a result of lateral refraction due to the unequal density of the atmosphere in the woods and over the river. The explanation is entirely reasonable and is rendered almost conclusive by the checks at Grand Cut-off Bayou, Black Hawk, and Lum Point, where identically the same methods were pursued and the only known changed condition was the absence of the timber, the country being almost wholly cleared. It would be quite possible to determine a mean coefficient of refraction from the angles themselves and make a correction; but it would involve considerable labor and would give no more probable value than the adjustment made by Assistant Thomas, to wit: After the usual adjustment for horizon and triangle closures, the differences in logarithmic sines corresponding to a change of 1 second in the angles, opposite sides of continuation were taken out and summed. The difference between logarithms of computed and measured length of a base was divided by this sum and the quotient taken as the correction to these angles. The correction was applied with opposite signs to the two angles in each triangle, hence acted together to increase or diminish the side without disturbing the closure of the triangle. The finally adjusted angles satisfy triangle, base, and azimuth conditions.

Angles of the triangles were measured by an ordinary transit. Above Grand Bend the instrument used was 6-inch limb, with plate divided to 30 minutes and reading to single minute by two verniers; below that place the instrument used was made to order by Brandis & Co. It is a 4½-inch limb, with plate divided to 20 minutes and reading to 1 minute by two verniers, telescope inverting. The total reading, after repeating pointings to adjacent stations with plate and limb alternately clamped, was divided by the number of repetitions. Except in a few cases, triangles closed with an error less than 20 seconds and horizon less than 30 seconds. Azimuth and latitute were observed with an 8-inch limb transit, reading by verniers to 10 seconds and vertical circle reading to 20 seconds, having a level on the telescope; except at Barbin Landing and Mouth of Black River, where a 10-inch limb Gambey, graduated in the same manner, but without the level attached to the telescope, was used with an artificial horizon. Time was determined at Shreveport, Caspiana, Barbin Landing, and mouth of Black River, at which stations repeated pointings to circumpolar stars when near elongation or culmination were reduced for azimuth and latitude. Elsewhere azimuth observations were made by pointing to mark, then to star at elongation, and back to mark; and latitude was obtained from altitude of the star at culmination above the horizon indicated by the telescope level. The following table shows comparison on bases:

*Check on base lines.*

[Metric scale.]

| Base. | Number of triangles. | Length. | | Ratio of discrepancy. |
|---|---|---|---|---|
| | | Measured. | Calculated. | |
| Shreveport | ........ | 704.34 | ........ | ........ |
| Caspiana | 67 | 518.48 | 518.53 | 1 : 5184 |
| Coushatta | 76 | 609.90 | 609.94 | 1 : 15247 |
| High Die | 73 | 640.33 | 640.25 | 1 : 8004 |
| Colfax | 61 | 518.26 | 518.67 | 1 : 1264 |
| Alexandria | 47 | 955.68 | 955.78 | 1 : 9556 |
| Grand Bend | 23 | 609.81 | 609.85 | 1 : 15245 |
| Barbin Landing | 80 | 571.88 | 571.47 | 1 : 6348 |
| Murry Landing | 19 | 893.16 | 893.60 | 1 : 2012 |
| Larto Landing | 14 | 578.16 | 578.35 | 1 : 3027 |
| Black River | 17 | 457.37 | 457.62 | 1 : 1829 |
| Red Light Landing | 10 | 700.83 | 700.90 | 1 : 10460 |
| Bayou Cocodrie | 13 | 1,017.03 | 1,017.37 | 1 : 2991 |
| Grand Cut-off Bayou | 6 | 892.46 | 892.48 | 1 : 49581 |
| Black Hawk | 8 | 839.71 | 839.83 | 1 : 7177 |
| Lum Point | 19 | 1,921.82 | 1,921.86 | 1 : 48045 |

| Base. | Azimuth. | | Discrepancy. | Latitude. | | Station. |
|---|---|---|---|---|---|---|
| | Observed. | Carried. | | Observed. | Carried. | |
| | ° ′ ″ | ° ′ ″ | ′ ″ | ° ′ ″ | ° ′ ″ | |
| Shreveport | 276 44 42 | ........ | ........ | 32 31 38 | ........ | W. B. |
| Caspiana | 178 06 08 | 178 06 54 | 0 46 | 32 18 46 | ........ | △ 66. |
| Coushatta | 234 46 55 | 234 45 12 | 1 43 | ........ | ........ | |
| High Die | 307 52 29 | 307 52 08 | 0 21 | 31 40 50 | ........ | N. B. |
| Colfax | 160 07 59 | 160 09 03 | 1 14 | 31 29 50 | ........ | S. B. |
| Alexandria | 261 48 21 | 261 46 58 | 1 23 | 31 17 47 | ........ | N. B. |
| Grand Bend | 239 34 34 | 239 36 16 | 1 42 | 31 12 33 | ........ | S. W. B. |
| Barbin Landing | 182 33 36 | 182 34 58 | 1 22 | 31 11 05 | ........ | S. B. |
| Murry Landing | ........ | ........ | ........ | ........ | ........ | ........ |
| Larto Landing | ........ | ........ | ........ | ........ | ........ | ........ |
| Black River | 301 58 45 | 301 58 27 | 0 18 | 31 15 38 | 31 15 31 | W. B. |
| Red Light Landing | ........ | ........ | ........ | ........ | ........ | ........ |
| Bayou Cocodrie | ........ | ........ | ........ | ........ | ........ | ........ |
| Grand Cut-off Bayou | ........ | ........ | ........ | ........ | ........ | ........ |
| Black Hawk | ........ | ........ | ........ | ........ | ........ | ........ |
| Lum Point | 224 20 44 | 224 20 26 | 0 18 | 31 02 29 | 31 02 37 | S. B. |

No distribution of the error in lengths has been made through the sides, since the error, except in one stretch, does not enter in the lengths as given to the tenths place in the table. As has been stated, between Barbin Landing and Bayou Cocodrie, the adjusted angles have been used in computing the sides, and hence the calculated lengths check the measured lengths on the bases and presumably would check any intermediate base that might be interpolated. A correction of half the discrepancy in azimuth has been applied to the sides in the last half of the triangles of the stretch in which the discrepancy accumulated. Lengths of bases and sides are at their own elevation, and the triangles have been treated as plane. Elevations were obtained by checked levels with a Y-level connecting stations and precise bench marks. Stations on the right of the system are designated by even and on the left by odd numbers continuously from Shreveport down the river.

### TABLE I.—TABULATED RESULTS OF THE TERTIARY TRIANGULATION OF RED RIVER FROM SHREVEPORT, LA., TO LUM POINT, LOUISIANA.

[Assistant Engineer T. C. Thomas, chief of party; F. B. French, R. S. Buck, Walter H. Polk, Eugene Van Allen, and E. T. Washburn, observers; E. J. Thomas, Chas. H. Schermerhorn, and Fred. McCalla, levelers.]

[NOTE.—Elevations are referred to the Cairo Datum, and each elevation applies to the first of the △ s' standing opposite.]

| Side. | Distance. | Azimuth. | Elevation. | Side. | Distance. | Azimuth. | Elevation. |
|---|---|---|---|---|---|---|---|
| | *Meters.* | ° ′ | *Meters.* | | *Meters.* | ° ′ | *Meters.* |
| W. B.—E. B.* | 704.3 | 296 45 | 58.37 | 32—29 | 574.9 | 241 15 | 55.34 |
| E. B.—2 | 707.8 | 62 54 | 59.83 | 32—34 | 764.1 | 285 20 | ........ |
| 2—W. B | 639.4 | 180 06 | 58.44 | 34—29 | 532.2 | 154 04 | ........ |
| W. B.—1 | 982.9 | 268 11 | ........ | 29—31 | 893.3 | 297 43 | ........ |
| 1—2 | 1,190.5 | 55 43 | ........ | 31—34 | 561.5 | 83 33 | ........ |
| 2—4 | 1,183.4 | 289 25 | ........ | 34—34*a* | 943.6 | 313 33 | 55.27 |
| 4—1 | 1,072.4 | 172 54 | 74.87 | 34*a*—31 | 724.2 | 169 59 | 54.93 |
| 1—3 | 1,095.7 | 298 04 | ........ | 31—33 | 1,194.8 | 300 30 | ........ |
| 3—4 | 998.6 | 56 40 | ........ | 33—34*a* | 909.9 | 83 16 | ........ |
| 4—6 | 1,041.4 | 285 38 | ........ | 34*a*—36 | 834.2 | 298 57 | ........ |
| 6—3 | 846.2 | 168 31 | 59.48 | 36—33 | 539.4 | 198 47 | ........ |
| 3—5 | 1,233.1 | 319 00 | ........ | 33—35 | 887.0 | 326 30 | ........ |
| 5—6 | 648.4 | 99 00 | 58.95 | 35—36 | 701.8 | 109 03 | 55.34 |
| 6—8 | 837.8 | 342 08 | ........ | 36—38 | 742.9 | 332 33 | ........ |
| 8—5 | 794.6 | 208 51 | ........ | 38—35 | 536.8 | 216 43 | 55.04 |
| 5—7 | 882.3 | 303 27 | ........ | 35—37 | 949.7 | 335 43 | ........ |
| 7—8 | 1,149.8 | 78 50 | 59.04 | 37—38 | 834.2 | 121 28 | 53.50 |
| 8—9 | 1,162.4 | 293 16 | ........ | 38—40 | 1,348.9 | 352 37 | ........ |
| 9—7 | 684.4 | 185 02 | ........ | 40—37 | 1,050.7 | 210 49 | ........ |
| 9—10 | 749.4 | 44 43 | ........ | 37—39 | 1,674.9 | 347 25 | ........ |
| 10—9 | 1,129.4 | 151 24 | ........ | 39—40 | 1,162.9 | 129 02 | 54.22 |
| 10—12 | 1,060.4 | 328 19 | ........ | 40—40*a* | 1,588.5 | 343 17 | 54.06 |
| 12—9 | 1,435.1 | 178 49 | 59.02 | 40*a*—39 | 906.5 | 209 30 | 53.17 |
| 9—11 | 1,268.0 | 310 33 | ........ | 40*a*—42 | 650.4 | 289 48 | ........ |
| 11—12 | 1,115.7 | 56 49 | ........ | 42—39 | 1,022.9 | 170 41 | ........ |
| 12—14 | 1,291.8 | 318 30 | ........ | 39—41 | 1.205.8 | 311 47 | ........ |
| 14—11 | 1,579.8 | 182 49 | 57.49 | 41—42 | 761.9 | 74 20 | ........ |
| 11—13 | 1,691.4 | 325 39 | ........ | 42—44 | 1,071.8 | 293 44 | 53.43 |
| 13—14 | 1,048.0 | 80 01 | 56.93 | 44—41 | 683.4 | 158 46 | ........ |
| 14—16 | 1,372.4 | 326 27 | ........ | 41—43 | 1,021.2 | 292 52 | ........ |
| 16—13 | 1,353.2 | 191 40 | 59.41 | 43—44 | 733.9 | 70 54 | ........ |
| 13—15 | 1,225.0 | 335 47 | ........ | 44—46 | 1,130.3 | 294 53 | 55.40 |
| 15—16 | 803.4 | 75 00 | ........ | 46—43 | 789.0 | 155 07 | 55.66 |
| 16—18 | 877.9 | 341 24 | ........ | 43—45 | 1,035.6 | 289 37 | ........ |
| 18—15 | 1,151.7 | 205 31 | 57.25 | 45—46 | 741.8 | 60 14 | ........ |
| 15—17 | 872.8 | 338 47 | ........ | 46—48 | 698.2 | 290 26 | ........ |
| 17—18 | 842.8 | 74 28 | ........ | 48—45 | 611.9 | 179 00 | ........ |
| 18—20 | 929.1 | 320 53 | ........ | 45—47 | 782.7 | 294 58 | ........ |
| 20—17 | 973.8 | 198 25 | 56.96 | 47—48 | 753.8 | 68 04 | 53.01 |
| 17—19 | 1,043.4 | 342 49 | ........ | 48—50 | 1,005.5 | 289 01 | ........ |
| 19—20 | 536.4 | 96 22 | 56.85 | 50—47 | 659.1 | 157 32 | 55.49 |
| 20—22 | 1,096.5 | 331 36 | ........ | 47—49 | 764.4 | 303 58 | ........ |
| 22—19 | 914.4 | 180 47 | ........ | 49—50 | 423.3 | 64 32 | 52.99 |
| 19—21 | 1,071.5 | 325 32 | ........ | 50—52 | 672.4 | 320 34 | ........ |
| 21—22 | 619.7 | 87 08 | 56.38 | 52—49 | 702.8 | 176 20 | 53.94 |
| 22—24 | 774.0 | 346 32 | ........ | 49—51 | 1,297.7 | 299 42 | ........ |
| 24—21 | 898.0 | 209 14 | ........ | 51—52 | 1,083.8 | 86 55 | 53.11 |
| 21—23 | 1,187.4 | 358 34 | ........ | 52—54 | 914.5 | 318 14 | ........ |
| 23—24 | 618.2 | 130 44 | 58.52 | 54—51 | 878.6 | 212 34 | 54.07 |
| 24—26 | 920.7 | 354 25 | ........ | 51—53 | 668.6 | 338 39 | ........ |
| 26—23 | 637.7 | 216 28 | ........ | 53—54 | 726.0 | 80 40 | 53.41 |
| 23—25 | 567.3 | 339 02 | ........ | 54—56 | 496.5 | 308 17 | ........ |
| 25—26 | 582.2 | 91 40 | 56.27 | 56—53 | 536.3 | 217 32 | 53.78 |
| 26—28 | 672.1 | 343 23 | ........ | 53—55 | 889.6 | 319 29 | ........ |
| 28—25 | 738.4 | 211 52 | ........ | 55—56 | 938.9 | 105 31 | 52.86 |
| 25—27 | 819.6 | 349 47 | ........ | 56—58 | 814.1 | 316 48 | ........ |
| 27—28 | 564.4 | 108 32 | 57.90 | 58—55 | 487.8 | 225 25 | 53.67 |
| 28—30 | 684.0 | 354 08 | ........ | 55—57 | 572.1 | 344 47 | ........ |
| 30—27 | 683.0 | 222 49 | ........ | 57—58 | 540.0 | 112 50 | ........ |
| 27—29 | 1,167.6 | 340 34 | ........ | 58—60 | 937.8 | 347 07 | ........ |
| 29—30 | 1,042.7 | 125 08 | 56.68 | 60—57 | 760.9 | 202 17 | 53.67 |
| 30—32 | 943.4 | 338 19 | 58.16 | 57—59 | 835.3 | 336 46 | ........ |

* Shreveport base line.

TABLE 1.—*Tabulated results of tertiary triangulation of Red River, etc.*—**Continued.**

| Side. | Distance. | Azimuth. | Elevation. | Side. | Distance. | Azimuth. | Elevation. |
|---|---|---|---|---|---|---|---|
|  | *Meters.* | ° ′ | *Meters.* |  | *Meters.* | ° ′ | *Meters.* |
| 59—60 | 621.2 | 95 52 | 52.48 | 98—95 | 594.0 | 217 42 | 50.34 |
| 60—62 | 599.2 | 326 36 | ........ | 95—97 | 403.8 | 319 32 | ........ |
| 62—59 | 523.3 | 213 25 | 52.19 | 97—98 | 646.2 | 75 25 | 50.45 |
| 59—61 | 792.1 | 339 03 | ........ | 98—100 | 637.5 | 304 13 | ........ |
| 61—62 | 646.8 | 117 56 | 53.14 | 100—97 | 530.5 | 190 40 | 50.11 |
| 62—N. B | 859.3 | 350 46 | ........ | 97—99 | 869.1 | 325 57 | ........ |
| N. B.—61 | 696.7 | 218 30 | 52.25 | 99—100 | 617.7 | 108 47 | 50.51 |
| 61—63 | 826.8 | 352 51 | ........ | 100—102 | 857.6 | 13 23 | ........ |
| 63—N. B | 602.8 | 117 09 | 52.13 | 102—99 | 1,008.3 | 230 58 | 50.24 |
| 63—S. B. | 573.3 | 64 55 | ........ | 99—101 | 1,168.0 | 337 34 | ........ |
| S. B.—N. B.* | 518.4 | 178 06 | ........ | 101—102 | 1,307.0 | 109 53 | 50.54 |
| N. B.—66 | 781.1 | 358 06 | ........ | 102—104 | 1,378.0 | 339 34 | ........ |
| 66—63 | 718.5 | 225 16 | 52.09 | 104—101 | 1,129.7 | 221 27 | 49.72 |
| 63—65 | 1,007.4 | 8 34 | ........ | 101—103 | 1,083.1 | 354 31 | ........ |
| 65—66 | 608.7 | 143 42 | 52.71 | 103—104 | 882.4 | 105 12 | 49.76 |
| 66—68 | 746.8 | 4 32 | ........ | 104—106 | 1,207.7 | 336 26 | ........ |
| 68—65 | 490.3 | 238 48 | 52.27 | 106—103 | 949.9 | 202 50 | 50.49 |
| 65—67 | 478.6 | 340 25 | ........ | 103—105 | 1,321.4 | 328 51 | ........ |
| 67—68 | 612.4 | 108 46 | 52.73 | 105—106 | 1,082.7 | 103 38 | 50.29 |
| 68—70 | 699.4 | 332 49 | ........ | 106—108 | 1,449.8 | 342 14 | ........ |
| 70—67 | 498.5 | 211 29 | 51.95 | 108—105 | 1,279.9 | 208 27 | 48.98 |
| 70—70*a* | 794.7 | 285 38 | ........ | 105—107 | 1,563.9 | 346 48 | ........ |
| 70*a*—67 | 814.6 | 141 42 | 51.90 | 107—108 | 1,045.3 | 112 20 | 49.72 |
| 67—69 | 957.9 | 285 29 | ........ | 108—110 | 718.4 | 351 27 | ........ |
| 69—70*a* | 567.4 | 47 29 | 52.23 | 110—107 | 915.3 | 249 59 | 48.89 |
| 70*a*—72 | 791.6 | 282 44 | ........ | 107—109 | 1,254.2 | 20 34 | ........ |
| 72—69 | 660.8 | 147 37 | 51.33 | 109—110 | 957.8 | 154 02 | 49.19 |
| 69—71 | 1,124.1 | 279 10 | ........ | 110—112 | 811.7 | 46 16 | ........ |
| 71—72 | 845.5 | 63 23 | 52.02 | 112—109 | 1,049.7 | 286 36 | 48.93 |
| 72—74 | 1,071.0 | 293 22 | ........ | 109—111 | 921.4 | 17 38 | ........ |
| 74—71 | 835.2 | 164 12 | 52.46 | 111—112 | 1,384.1 | 148 20 | 50.28 |
| 71—73 | 972.5 | 308 08 | ........ | 112—114 | 1,145.3 | 11 37 | ........ |
| 73—74 | 574.7 | 69 18 | 51.22 | 114—111 | 959.1 | 273 22 | 49.88 |
| 74—76 | 906.5 | 305 17 | ........ | 111—113 | 1,146.3 | 11 39 | ........ |
| 76—73 | 754.1 | 164 27 | 52.13 | 113—114 | 1,384.6 | 148 22 | 49.78 |
| 73—75 | 1,080.9 | 310 30 | ........ | 114—116 | 1,980.3 | 3 40 | ........ |
| 75—76 | 620.3 | 87 44 | 52.09 | 116—113 | 1,167.6 | 226 56 | 49.09 |
| 76—78 | 960.3 | 307 54 | ........ | 113—115 | 1,477.7 | 352 54 | ........ |
| 78—75 | 629.8 | 167 21 | 51.00 | 115—116 | 1,232.7 | 122 52 | 49.65 |
| 75—77 | 752.4 | 301 07 | ........ | 116—118 | 1,762.2 | 343 56 | ........ |
| 77—78 | 554.2 | 65 58 | 52.14 | 118—115 | 1,161.6 | 208 08 | 48.72 |
| 78—80 | 563.2 | 306 33 | ........ | 115—117 | 1,461.8 | 332 55 | ........ |
| 80—77 | 563.7 | 185 28 | 50.95 | 117—118 | 1,244.4 | 102 52 | 48.64 |
| 77—79 | 802.8 | 331 27 | ........ | 118—120 | 1,566.8 | 326 08 | ........ |
| 79—80 | 460.5 | 108 13 | 51.44 | 120—117 | 1,078.7 | 198 22 | 48.81 |
| 80—82 | 694.1 | 335 53 | ........ | 117—119 | 1,915.4 | 329 14 | ........ |
| 82—79 | 513.1 | 197 26 | 51.79 | 119—120 | 1,459.1 | 115 14 | 49.13 |
| 79—81 | 820.1 | 332 19 | ........ | 120—122 | 2,560.9 | 333 51 | ........ |
| 81—82 | 591.9 | 114 24 | 51.87 | 122—119 | 1,687.4 | 186 30 | 47.44 |
| 82—84 | 958.8 | 342 35 | ........ | 119—121 | 1,290.6 | 305 22 | ........ |
| 84—81 | 716.1 | 200 36 | 51.26 | 121—122 | 1,552.4 | 53 13 | 48.63 |
| 81—83 | 1,211.5 | 312 21 | ........ | 122—124 | 2,176.1 | 277 14 | ........ |
| 83—84 | 1,156.6 | 97 14 | 52.12 | 124—121 | 1,511.9 | 142 44 | 47.45 |
| 84—86 | 1,179.0 | 312 25 | ........ | 121—123 | 1,626.4 | 287 38 | ........ |
| 86—83 | 706.0 | 203 06 | 51.91 | 123—124 | 952.6 | 41 46 | 49.04 |
| 83—85 | 981.6 | 325 04 | ........ | 123—125 | 1,176.3 | 320 40 | ........ |
| 85—86 | 853.3 | 100 29 | 52.14 | 125—124 | 1,394.6 | 98 13 | 49.16 |
| 86—88 | 948.1 | 324 35 | ........ | 124—126 | 1,178.6 | 318 58 | ........ |
| 88—85 | 681.8 | 205 07 | 50.28 | 126—125 | 917.7 | 221 22 | 48.33 |
| 85—87 | 648.8 | 338 16 | ........ | 125—127 | 1,411.6 | 352 30 | ........ |
| 87—88 | 529.9 | 88 25 | 51.52 | 127—126 | 1,063.2 | 131 58 | 47.32 |
| 88—90 | 620.2 | 333 15 | ........ | 126—128 | 1,409.9 | 359 10 | ........ |
| 90—87 | 621.2 | 203 48 | 50.74 | 128—127 | 1,040.1 | 227 47 | 48.79 |
| 87—89 | 828.2 | 333 27 | ........ | 127—129 | 1,311.6 | 341 32 | ........ |
| 89—90 | 644.3 | 105 32 | 51.09 | 129—128 | 1,305.2 | 114 41 | 48.79 |
| 90—92 | 1,066.5 | 338 48 | ........ | 128—130 | 2,220.2 | 333 42 | ........ |
| 92—89 | 854.8 | 195 58 | 50.06 | 130—129 | 1,459.4 | 187 58 | 47.39 |
| 89—91 | 1,037.6 | 338 58 | ........ | 129—131 | 2,206.0 | 309.50 | ........ |
| 91—92 | 625.1 | 103 34 | 50.28 | 131—130 | 1,896.4 | 89 02 | 47.06 |
| 92—94 | 900.3 | 346 57 | ........ | 130—132 | 1,528.7 | 303 48 | ........ |
| 94—91 | 834.8 | 208 58 | 50.47 | 132—131 | 1,081.8 | 215 21 | 47.25 |
| 91—93 | 1,087.6 | 350 08 | ........ | 132—134 | 917.7 | 259 46 | ........ |
| 93—94 | 682.2 | 120 00 | 51.17 | 134—131 | 770.8 | 158 55 | 47.70 |
| 94—96 | 1,060.3 | 343 20 | ........ | 131—133 | 744.1 | 290 19 | ........ |
| 96—93 | 733.0 | 203 01 | 50.71 | 133—134 | 623.9 | 42 23 | 47.57 |
| 93—95 | 1,135.0 | 344 26 | ........ | 133—135 | 1,125.3 | 323 11 | ........ |
| 95—96 | 724.5 | 125 19 | 50.82 | 135—134 | 1,180.1 | 111 54 | 45.74 |
| 96—98 | 917.5 | 345 37 | ........ | 134—136 | 785.4 | 324 18 | ........ |

*Caspiana Landing base line.

**TABLE 1.**—*Tabulated results of the tertiary triangulation of Red River, etc.*—**Cont'd.**

| Side. | Distance. | Azimuth. | Elevation. | Side. | Distance. | Azimuth. | Elevation. |
|---|---|---|---|---|---|---|---|
| | *Meters.* | ° ′ | *Meters.* | | *Meters.* | ° ′ | *Meters.* |
| 136—135 | 666.7 | 252 45 | 47.10 | 168—170 | 1,542.1 | 308 11 | ........ |
| 135—S. B. | 391.8 | 7 19 | ........ | 170—171 | 1,434.8 | 191 14 | 43.33 |
| S. B.—N. B.* | 609.9 | 154 47 | ........ | 171—173 | 1,947.7 | 301 36 | ........ |
| N. B.—135 | 350.1 | 297 47 | ........ | 173—170 | 1,976.5 | 78 43 | 43.06 |
| N. B.—136 | 487.0 | 42 11 | ........ | 170—172 | 1,707.9 | 336 39 | ........ |
| 136—S. B. | 617.1 | 288 01 | ........ | 172—173 | 2,326.6 | 212 50 | 43.45 |
| 136—138 | 601.4 | 357 12 | ........ | 172—174 | 1,600.1 | 285 30 | ........ |
| 138—135 | 1,073.6 | 214 10 | 47.04 | 174—173 | 2,399.0 | 173 17 | 44.34 |
| 135—137 | 1,256.0 | 341 56 | ........ | 173—175 | 3,324.5 | 320 30 | ........ |
| 137—138 | 1,038.5 | 107 07 | 48.51 | 175—174 | 1,843.0 | 95 42 | 42.74 |
| 138—140 | 1,479.5 | 343 26 | ........ | 174—176 | 2,116.6 | 321 49 | ........ |
| 140—137 | 1,250.8 | 207 09 | 46.60 | 176—175 | 1,571.5 | 199 32 | 41.99 |
| 137—139 | 981.0 | 324 48 | ........ | 176—177 | 2,485.5 | 288 48 | ........ |
| 139—140 | 1,177.9 | 74 42 | 47.94 | 177—175 | 2,923.2 | 141 18 | 41.38 |
| 140—142 | 1,836.1 | 319 10 | ........ | 175—178 | 4,295.0 | 354 36 | ........ |
| 142—139 | 1,701.4 | 177 50 | 45.86 | 178—177 | 2,448.5 | 215 30 | 58.01 |
| 139—141 | 1,725.7 | 322 29 | ........ | 177—179 | 1,928.6 | 329 17 | ........ |
| 141—142 | 1.041.0 | 71 26 | 46.35 | 179—178 | 2,430.3 | 82 04 | 41.52 |
| 142—144 | 912.1 | 319 46 | ........ | 178—180 | 3,055.5 | 301 22 | ........ |
| 144—141 | 1,101.9 | 201 09 | 44.20 | 180—179 | 1,935.9 | 174 01 | 42.54 |
| 141—143 | 1,048.6 | 343 51 | ........ | 179—181 | 2,669.4 | 310 12 | ........ |
| 143—144 | 689.6 | 88 17 | 44.78 | 181—180 | 1,847.9 | 83 43 | 41.07 |
| 144—146 | 1,109.0 | 325 37 | ........ | 180—182 | 2,662.5 | 311 25 | ........ |
| 146—143 | 937.9 | 183 51 | 46.76 | 182—181 | 1,970.2 | 175 21 | 41.81 |
| 143—145 | 1,634.9 | 323 46 | ........ | 181—183 | 2,795.8 | 320 56 | ........ |
| 145—146 | 1,098.1 | 110 25 | 45.90 | 183—182 | 1,615.5 | 97 22 | 41.41 |
| 146—148 | 1,576.3 | 332 18 | ........ | 182—184 | 2,714.1 | 323 38 | ........ |
| 148—145 | 1,054.5 | 196 19 | 45.88 | 184—183 | 1,978.4 | 179 47 | 35.45 |
| 145—147 | 1,701.5 | 335 44 | ........ | 183—185 | 2,797.5 | 314 23 | ........ |
| 147—148 | 1,132.1 | 118 26 | 47.64 | 185—184 | 1,992.2 | 89 22 | 39.35 |
| 148—150 | 1,645.1 | 347 08 | ........ | 184—186 | 2,732.3 | 351 19 | ........ |
| 150—147 | 1,236.7 | 210 34 | 44.34 | 186—185 | 3,146.8 | 210 08 | 39.27 |
| 147—149 | 1,534.0 | 323 40 | ........ | 185—187 | 2,541.6 | 357 30 | ........ |
| 149—150 | 1,547.3 | 96 21 | 46.44 | 187—186 | 1,700.7 | 83 51 | 38.68 |
| 150—152 | 2,143.7 | 329 23 | ........ | 186—188 | 1,441.7 | 337 48 | ........ |
| 152—149 | 1,732.3 | 194 56 | 44.80 | 188—187 | 1,901.6 | 217 04 | 38.51 |
| 149—151 | 2,068.5 | 330 54 | ........ | 188—190 | 1,733.3 | 278 14 | ........ |
| 151—152 | 1,458.5 | 95 15 | 46.91 | 190—187 | 1,854.8 | 162 08 | 39.38 |
| 152—154 | 1,454.1 | 313 21 | ........ | 187—189 | 1,704.0 | 292 28 | ........ |
| 154—151 | 950.8 | 204 33 | 44.84 | 189—190 | 1,500.7 | 42 04 | 39.86 |
| 154—154*a* | 1,634.6 | 276 47 | ........ | 189—192 | 2.097.2 | 352 15 | ........ |
| 154*a*—151 | 1,620.8 | 130 44 | 44.61 | 192—190 | 1,608.9 | 126 48 | 39.17 |
| 151—153 | 2,263.6 | 257 17 | ........ | 190—191 | 2,369.1 | 271 11 | ........ |
| 153—154*a* | 1,838.9 | 32 12 | 45.85 | 191—192 | 1,415.9 | 49 44 | 39.03 |
| 153—155 | 1,607.9 | 304 22 | ........ | 192—193 | 1,638.9 | 278 47 | ........ |
| 156—154*a* | 2,396.5 | 74 18 | 46.57 | 193—191 | 1,284.2 | 155 10 | 38.38 |
| 154*a*—156 | 3,002.2 | 288 05 | ........ | 191—194 | 1,916.1 | 9 33 | ........ |
| 156—155 | 1,671.0 | 160 55 | 45.75 | 194—193 | 1,122.0 | 229 49 | 39.10 |
| 155..157 | 1,627.8 | 258 29 | ........ | 193—195 | 1,358.2 | 349 42 | ........ |
| 157—156 | 2,173.9 | 28 51 | 55.94 | 195—194 | 1,258.8 | 119 07 | 53.85 |
| 157—158 | 2,770.4 | 345 23 | ........ | 195—196 | 1,319.1 | 37 58 | ........ |
| 158—156 | 1,912.7 | 113 57 | 44.39 | 196—194 | 1,677.2 | 170 06 | 39.18 |
| 156—159 | 3,172.2 | 254 35 | ........ | 194—197 | 2,339.0 | 314 46 | ........ |
| 159—158 | 2,083.2 | 38 58 | 54.15 | 197—196 | 1,372.3 | 89 48 | 38.31 |
| 159—161 | 2,019.8 | 4 12 | ........ | 196—198 | 1,899.7 | 312 47 | ........ |
| 161—158 | 1,227.0 | 108 44 | 44.30 | 198—197 | 1,295.2 | 179 01 | 38.65 |
| 158—160 | 1,834.9 | 326 12 | ........ | 197—199 | 1,840.4 | 315 04 | ........ |
| 160—161 | 1,139.5 | 187 07 | 43.99 | 199—198 | 1,277.8 | 90 22 | 38.30 |
| 161—163 | 1,169.7 | 273 36 | ........ | 198—200 | 1,927.7 | 322 31 | ........ |
| 163—160 | 1,682.5 | 51 04 | 44.10 | 200—199 | 1,525.1 | 183 56 | 38.55 |
| 160—162 | 2,793.5 | 263 44 | ........ | 199—201 | 1,495.8 | 305 08 | ........ |
| 162—163 | 1,649.8 | 117 08 | 43.06 | 201—200 | 1,483.0 | 63 33 | 37.26 |
| 163—163*a* | 1,674.0 | 253.25 | ........ | 201—N. B | 1,037.9 | 7 11 | ........ |
| 163*a*—162 | 1,238.8 | 6 20 | 43.01 | N. B.—200 | 1,253.7 | 107 08 | 38.21 |
| 163*a*—165 | 1,667.2 | 264 40 | ........ | 200—202 | 1,638.4 | 322 00 | ........ |
| 165—162 | 2.269.1 | 52 21 | 52.64 | 202—N. B | 941.1 | 191 37 | 37.17 |
| 162—164 | 1,423.8 | 291 06 | ........ | 202—S. B | 873.2 | 232 44 | ........ |
| 164—165 | 1,955.3 | 193 51 | 45.62 | S. B.—N. B.† | 640.3 | 127 52 | ........ |
| 165—166 | 2,666.2 | 319 15 | ........ | N. B.—205 | 1,380.7 | 297 14 | ........ |
| 166—164 | 2,211.6 | 93 09 | 42.79 | 205—202 | 1,446.4 | 78 26 | 37.60 |
| 164—167 | 2,191.9 | 230 52 | ........ | 202—204 | 1,836.1 | 303 25 | ........ |
| 167—166 | 1,588.3 | 341 21 | 50.00 | 204—205 | 1,306.0 | 174 55 | 36.49 |
| 166—169 | 1,863.8 | 202 25 | ........ | 205—205*a* | 2,123.1 | 321 41 | ........ |
| 169—167 | 1,238.2 | 79 51 | 43.06 | 205*a*—204 | 1,255.1 | 106 54 | 59.08 |
| 167—168 | 1,760.6 | 308 30 | ........ | 205*a*—206 | 1,601.8 | 41 01 | ........ |
| 168—169 | 1,323.8 | 173 06 | 43.73 | 206—204 | 1,580.5 | 174 34 | 36.19 |
| 169—171 | 1,860.5 | 297 31 | ........ | 204—207 | 1,545.8 | 317 36 | ........ |
| 171—168 | 1,559.0 | 73 02 | 44.10 | 207—206 | 991.6 | 64 11 | 54.02 |

*Coushatta base line.

† High die base line.

TABLE 1.—*Tabulated results of tertiary triangulation of Red River, etc.*—Continued.

| Side. | Distance. | Azimuth. | Elevation. | Side. | Distance. | Azimuth. | Elevation. |
|---|---|---|---|---|---|---|---|
| | *Meters.* | ° ′ | *Meters.* | | *Meters.* | ° ′ | *Meters.* |
| 207—208 | 1,210.5 | 23 59 | ........ | 246—245 | 441.1 | 197 04 | 34.64 |
| 208—206 | 784.1 | 149 17 | 35.18 | 245—247 | 721.4 | 337 51 | ........ |
| 206—209 | 1,046.4 | 294 48 | ........ | 247—246 | 471.0 | 121 33 | 33.57 |
| 209—208 | 597.5 | 66 49 | 46.14 | 246—248 | 820.2 | 333 12 | ........ |
| 209—210 | 1,073.0 | 358 41 | ........ | 248—247 | 486.6 | 183 43 | 34.53 |
| 210—208 | 1,015.3 | 145 35 | 35.48 | 247—249 | 582 7 | 311 06 | ........ |
| 208—211 | 1,048.0 | 287 11 | ........ | 249—248 | 481.7 | 77 43 | 33.53 |
| 211—210 | 679.1 | 39 00 | 38.24 | 248—250 | 573.9 | 309 14 | ........ |
| 210—212 | 1,010.0 | 303 41 | ........ | 250—249 | 466.2 | 183 13 | 35.54 |
| 212—211 | 1,163.4 | 159 13 | 34.64 | 249—252 | 832.4 | 328 24 | ........ |
| 211—213 | 1,317.0 | 293 14 | ........ | 252—250 | 522.5 | 117 47 | 27.71 |
| 213—212 | 979.0 | 54 32 | 44.66 | 250—251 | 888.6 | 264 52 | ........ |
| 212—214 | 1,047.7 | 270 40 | ........ | 251—252 | 532.1 | 52 37 | 33.02 |
| 214—213 | 632.0 | 156 40 | 35,07 | 251—254 | 632.9 | 359 27 | ........ |
| 213—215 | 871.9 | 289 54 | ........ | 254—252 | 529.0 | 125 51 | 34.50 |
| 215—214 | 636.1 | 63 32 | 34.92 | 252—253 | 708.6 | 271 51 | ........ |
| 214—216 | 863.1 | 280 31 | ........ | 253—254 | 400.5 | 44 15 | 32.69 |
| 216—215 | 522.0 | 147 40 | 36.77 | 254—255 | 722.0 | 280 36 | ........ |
| 215—217 | 624.9 | 282 12 | ........ | 255—253 | 601.1 | 134 18 | 33.10 |
| 217—216 | 453.3 | 47 02 | 46.98 | 253—256 | 891.1 | 347 01 | ........ |
| 216—218 | 659.0 | 291 52 | ........ | 256—255 | 504.1 | 207 09 | 32.79 |
| 218—217 | 621.1 | 153 13 | 34.96 | 255—258 | 824.4 | 343 27 | ........ |
| 217—219 | 1,050.4 | 293 38 | ........ | 258—256 | 576.9 | 126 19 | 34.18 |
| 219—218 | 695.3 | 78 56 | 46.81 | 256—257 | 996.4 | 268 37 | ........ |
| 218—220 | 941.9 | 310 17 | ........ | 257—258 | 645.0 | 55 27 | 35.02 |
| 220—219 | 743.2 | 177 13 | 36.48 | 258—260 | 608.9 | 297 45 | ........ |
| 219—221 | 996.1 | 300 20 | ........ | 260—257 | 649.3 | 179 19 | 34.66 |
| 221—220 | 857.7 | 73 48 | 34.66 | 257—N. B | 613.0 | 268 23 | ........ |
| 220—222 | 1,324.7 | 288 07 | ........ | N. B.—S. B.* | 518.3 | 340 08 | ........ |
| 222—221 | 783.4 | 146 15 | 36.59 | S. B.—260 | 801.0 | 77 07 | 35.92 |
| 221—223 | 1,347.5 | 277 24 | ........ | 260—N. B | 899.6 | 222 14 | ........ |
| 223—222 | 1,019.8 | 62 04 | 33.99 | 260—260*a* | 983.2 | 331 56 | ........ |
| 222—224 | 1,279.0 | 291 05 | ........ | 260*a*—S. B | 1,093.6 | 196 55 | 35.60 |
| 224—223 | 982.4 | 162 41 | 35.90 | S. B.—261 | 1,160.6 | 333 40 | ........ |
| 223—225 | 1,118.1 | 304 15 | ........ | 261—260*a* | 833.3 | 89 34 | 35.63 |
| 225—224 | 703.8 | 63 58 | 32.90 | 260*a*—262 | 1,560.7 | 335 12 | ........ |
| 224—226 | 1,249.2 | 280 57 | ........ | 262—261 | 1,434.2 | 187 10 | 38.18 |
| 226—225 | 807.0 | 132 36 | 35.47 | 261—263 | 1,492.7 | 325 44 | ........ |
| 225—227 | 869.6 | 269 48 | ........ | 263—262 | 1,036.7 | 79 28 | 36.41 |
| 227—226 | 614.6 | 26 38 | 41.51 | 262—264 | 1,665.2 | 311 26 | ........ |
| 226—229 | 935.4 | 245 03 | ........ | 264—263 | 1,311.6 | 169 56 | 36.34 |
| 229—227 | 593.0 | 105 08 | 41.32 | 263—265 | 1,600.4 | 304 50 | ........ |
| 227—228 | 806.2 | 318 36 | ........ | 265—264 | 1,148.2 | 70 49 | 35.63 |
| 228—229 | 451.8 | 185 00 | 35.92 | 265—265*a* | 1,157.3 | 00 47 | ........ |
| 229—231 | 826.1 | 294 55 | ........ | 265*a*—264 | 1,323.1 | 126 07 | 35.20 |
| 231—228 | 795.2 | 82 37 | 47.71 | 264—266 | 1,334.8 | 354 06 | ........ |
| 228—230 | 734.4 | 294 37 | ........ | 266—265*a* | 1,080.6 | 239 33 | 34.82 |
| 230—231 | 425.6 | 196 30 | 35.35 | 265*a*—267 | 1,509.1 | 13 29 | ........ |
| 231—233 | 775.5 | 314 02 | ........ | 267—266 | 1,087.2 | 147 47 | 35.08 |
| 233—230 | 691.0 | 100 56 | 34.86 | 266—268 | 1,629.3 | 18 47 | ........ |
| 230—232 | 671.7 | 321 22 | ........ | 268—267 | 1,267.9 | 240 35 | 36.10 |
| 232—233 | 471.4 | 213 21 | 36.00 | 267—269 | 1,652.2 | 3 33 | ........ |
| 233—235 | 702.3 | 302 23 | ........ | 269—268 | 1,434.3 | 135 41 | 34.47 |
| 235—232 | 852.4 | 88 49 | 35.15 | 268—270 | 2,170.3 | 6 49 | ........ |
| 232—234 | 982.7 | 308 57 | ........ | 270—269 | 1,691.3 | 228 08 | 42.20 |
| 234—235 | 641.3 | 187 53 | 33.51 | 269—271 | 1,623.6 | 328 11 | ........ |
| 235—235*a* | 903.6 | 323 55 | ........ | 271—270 | 2,130.5 | 96 46 | 34.95 |
| 235*a*—234 | 627.3 | 98 43 | 35.24 | 270—272 | 1,818.6 | 331 27 | ........ |
| 234—236 | 1,038.5 | 327 09 | ........ | 272—271 | 1,834.1 | 222 49 | 30.09 |
| 236—235*a* | 779.4 | 184 10 | 33.87 | 272—272*a* | 1,416.2 | 312 32 | ........ |
| 235*a*—237 | 1,205.1 | 329 14 | ........ | 272*a*—271 | 2,311.6 | 185 02 | 35.38 |
| 237—236 | 720.9 | 110 59 | 41.55 | 271—273 | 2,548.4 | 327 30 | ........ |
| 236—238 | 1,139.2 | 328 47 | ........ | 273—272*a* | 1,579.7 | 84 25 | 33.11 |
| 238—237 | 720.9 | 186 36 | 35.05 | 272*a*—274 | 1,641.9 | 332 22 | ........ |
| 237—239 | 750.2 | 315 10 | ........ | 274—273 | 1,806.9 | 206 45 | 34.85 |
| 239—238 | 638.8 | 73 15 | 34.41 | 273—275 | 1,769.2 | 336 14 | ........ |
| 238—240 | 1,001.7 | 292 59 | ........ | 275—274 | 1,523.8 | 90 25 | 33.10 |
| 240—239 | 653.7 | 151 39 | 34.24 | 274—277 | 2,080.4 | 306 50 | ........ |
| 239—241 | 949.1 | 291 57 | ........ | 277—275 | 1,244.1 | 173 28 | 33.86 |
| 241—240 | 611.4 | 68 51 | 35.20 | 275—276 | 1,700.4 | 88.47 | ........ |
| 240—243 | 1,129.2 | 295 55 | ........ | 276—277 | 1,209.7 | 265 45 | 34.91 |
| 243—241 | 841.6 | 148 03 | 33.80 | 276—278 | 1,677.0 | 319 03 | ........ |
| 241—242 | 986.5 | 7 49 | ........ | 278—277 | 1,360.4 | 184 31 | 32.26 |
| 242—243 | 636.6 | 245 35 | 34.23 | 277—279 | 1,699.0 | 309 05 | ........ |
| 242—244 | 690.9 | 346 13 | ........ | 279—278 | 1,454.1 | 78 42 | 32.37 |
| 244—243 | 1,022.2 | 203 57 | 35.03 | 278—280 | 1,431.1 | 305 34 | ........ |
| 243—245 | 977.1 | 345 48 | ........ | 280—279 | 1,148.7 | 193 03 | 31.96 |
| 245—244 | 654.7 | 91 08 | 33.08 | 280—282 | 1,825.9 | 282 50 | ........ |
| 244—246 | 681.8 | 309 37 | ........ | 282—279 | 2,153.6 | 135 05 | 32.96 |

*Colfax base line.

TABLE I.—*Tabulated results of tertiary triangulation of Red River survey, etc.*—Cont'd.

| Side. | Distance. | Azimith. | Elevation. | Side. | Distance. | Azimith. | Elevation. |
|---|---|---|---|---|---|---|---|
| | *Meters.* | ° ′ | *Meters.* | | *Meters.* | ° ′ | *Meters.* |
| 279—281 | 1,881.0 | 273 44 | ........ | 317—316 | 747.8 | 80 48 | 29.59 |
| 281—282 | 1,446.7 | 14 15 | 31.53 | 316—318 | 533.2 | 320 16 | ........ |
| 281—283 | 1,243.6 | 322 54 | ........ | 318—317 | 662.1 | 216 52 | 28.39 |
| 283—282 | 1,179.9 | 69 39 | 32.45 | 318—SW. B | 951.9 | 269 40 | ........ |
| 282—284 | 1,399.5 | 296 05 | ........ | SW. B.—317 | 763.1 | 183 23 | 27.846 |
| 284—283 | 1,035.7 | 171 39 | 32.81 | 317—NE. B | 1,101.8 | 281 17 | ........ |
| 283—285 | 1,661.6 | 272 43 | ........ | NE. B.—SW. B.† | 609.8 | 59 35 | 29.39 |
| 285—284 | 1,781.4 | 57 55 | 31.72 | SW. B.—319 | 901.6 | 320 37 | ........ |
| 284—286 | 2,461.8 | 283 07 | ........ | 319—NE. B | 1,006.7 | 177 22 | 28.72 |
| 286—285 | 1,747.3 | 149 27 | 32.78 | NE. B.—320 | 1,038.0 | 32 14 | ........ |
| 285—285*a* | 1,537.1 | 263 29 | ........ | 320—319 | 613.3 | 282 01 | 30.86 |
| 285*a*—286 | 1,796.6 | 20 50 | 31.42 | 319—321 | 733.2 | 34 42 | ........ |
| 285*a*—287 | 1.826.3 | 280 05 | ........ | 321—320 | 753.0 | 165 58 | 28.68 |
| 287—286 | 2,790.6 | 60 51 | 31.01 | 320—323 | 1,307.6 | 27 26 | ........ |
| 286—288 | 3,813.9 | 282 53 | ........ | 323—321 | 896.1 | 241 17 | 27.85 |
| 288—287 | 2,554.3 | 149 54 | 31.33 | 321—322 | 1,110.8 | 100 42 | ........ |
| 287—289 | 2,313.6 | 289 14 | ........ | 322—323 | 706.4 | 334 17 | 28.05 |
| 289—288 | 1,707.6 | 32 00 | 29.82 | 322—324 | 764.0 | 14 46 | ........ |
| 288—290 | 1,928.9 | 258 09 | ........ | 324—323 | 511.6 | 258 28 | 30.02 |
| 290—289 | 1,439.8 | 136 56 | 32.56 | 323—326 | 932.0 | 23 24 | ........ |
| 289—289*a* | 1,186.6 | 276 41 | ........ | 326—324 | 764.4 | 170 08 | ........ |
| 289*a*—290 | 949.3 | 18 06 | 31.40 | 324—325 | 1,319.8 | 318 02 | ........ |
| 289*a*—291 | 1,285.3 | 296 36 | ........ | 325—326 | 785.4 | 106 53 | 28.85 |
| 291—290 | 1,480.5 | 77 15 | 31.15 | 326—326*a* | 833.9 | 331 24 | ........ |
| 290—292 | 2,150.9 | 298 12 | ........ | 326*a*—325 | 615.0 | 214 58 | ........ |
| 292—291 | 1,417.1 | 161 25 | 30.24 | 326*a*—328 | 904.4 | 299 22 | ........ |
| 291—293 | 2,220.9 | 298 27 | ........ | 328—325 | 1,043.0 | 155 18 | 27.35 |
| 293—292 | 1,528.0 | 79 15 | 30.67 | 325—327 | 1,784.9 | 297 11 | ........ |
| 292—294 | 1.875.2 | 342 39 | ........ | 327—328 | 1,159.5 | 83 27 | 28.59 |
| 294—293 | 2,278.7 | 204 25 | 31.58 | 328—330 | 1,474.3 | 308 00 | ........ |
| 293—295 | 1,737.0 | 343 41 | ........ | 330—327 | 1,040.0 | 179 28 | 26.14 |
| 295—294 | 1,486.9 | 74 04 | 30.56 | 327—329 | 1,298.1 | 322 48 | ........ |
| 294—296 | 2,085.9 | 293 55 | ........ | 329—330 | 775.0 | 89 33 | 28.68 |
| 296—295 | 1,340.4 | 159 10 | 30.97 | 330—332 | 1,234.3 | 307 35 | ........ |
| 295—297 | 2,094.4 | 285 00 | ........ | 332—329 | 785.6 | 165 01 | 25.75 |
| 297—296 | 1,701.8 | 65 19 | 29.66 | 329—331 | 1,517.9 | 284 26 | ........ |
| 296—298 | 2,096.5 | 310 20 | ........ | 331—332 | 1,322.7 | 73 17 | 28.07 |
| 298—297 | 2,068.5 | 178.34 | 30.93 | 332—332*a* | 1,361.2 | 285 52 | ........ |
| 297—299 | 2,456.1 | 299 52 | ........ | 332*a*—331 | 753.8 | 176 47 | 27.03 |
| 299—298 | 2,242.8 | 67 54 | 46.52 | 332*a*—333 | 1,365.5 | 254 30 | ........ |
| 298—SW. B | 883.4 | 336 12 | ........ | 333—331 | 1,412.4 | 105 55 | 27.77 |
| SW. B.—NE. B* | 955.7 | 261 48 | 31.58 | 331—334 | 1,444.3 | 320 18 | ........ |
| NE. B.—299 | 1,702.9 | 207 06 | 30.21 | 334—333 | 844.6 | 211 02 | 25.44 |
| NE. B.—298 | 1,465.5 | 117 18 | ........ | 333—335 | 1,111.9 | 334 21 | ........ |
| 298—300 | 2,856.4 | 316 25 | ........ | 335—334 | 958.2 | 106 54 | 28.15 |
| 300—299 | 2,914.9 | 182 08 | 29.84 | 334—336 | 1,309.6 | 330 32 | ........ |
| 299—301 | 1,875.8 | 330 12 | ........ | 336—335 | 903.6 | 197 33 | 29.91 |
| 301—300 | 1,653.9 | 39 00 | 29.84 | 335—338 | 1,464.0 | 342 43 | ........ |
| 301—303 | 1,117.4 | 298 52 | ........ | 338—336 | 887.9 | 127 10 | 26.71 |
| 303—300 | 2,152.8 | 69 44 | 30.49 | 336—337 | 1,194.5 | 242 22 | ........ |
| 300—302 | 1,541.5 | 288 13 | ........ | 337—338 | 1,145.4 | 17 50 | ........ |
| 302—303 | 1,347.5 | 204 20 | 28.23 | 338—340 | 1,213.7 | 252 59 | ........ |
| 302—304 | 1,239.5 | 304 28 | ........ | 340—337 | 1,093.7 | 132 14 | 25.96 |
| 304—303 | 1,984.8 | 166 24 | 28.19 | 337—339 | 1,579.1 | 269 33 | ........ |
| 303—305 | 1,721.4 | 310 41 | ........ | 339—340 | 1,072.8 | 45 49 | 28.23 |
| 305—304 | 1,165.0 | 46 08 | 29.80 | 339—342 | 1,633.9 | 356 38 | ........ |
| 305—307 | 1,437.0 | 328 17 | ........ | 342—340 | 1,236.6 | 135 35 | 26.78 |
| 307—304 | 1,648.5 | 104 35 | 28.35 | 340—341 | 1,281.8 | 278 24 | ........ |
| 304—306 | 1,408.6 | 325 01 | ........ | 341—342 | 1,167.3 | 58 35 | 27.96 |
| 306—307 | 1,080.3 | 226 50 | 28.14 | 341—343 | 1,070.8 | 16 50 | ........ |
| 306—308 | 1,070.5 | 306 28 | ........ | 343—342 | 802.4 | 121 13 | 27.26 |
| 308—307 | 1,377.3 | 176 58 | 27.65 | 342—344 | 1,226.9 | 333 04 | ........ |
| 307—309 | 1,001.2 | 318 10 | ........ | 344—343 | 690.4 | 190 53 | 26.40 |
| 309—308 | 865.9 | 43 23 | 30.26 | 343—345 | 1,086.1 | 338 49 | ........ |
| 308—310 | 1,293.9 | 306 57 | ........ | 345—344 | 620.9 | 122 38 | 27.45 |
| 310—309 | 1,474.1 | 162 39 | 27.90 | 345—346 | 1,100.1 | 52 56 | ........ |
| 309—311 | 1,506.2 | 312 20 | ........ | 346—344 | 1,059.0 | 199 35 | 25.87 |
| 311—310 | 800.0 | 68 52 | 29.89 | 344—347 | 1,592.6 | 346 18 | ........ |
| 310—312 | 987.9 | 326 20 | ........ | 347—346 | 915.3 | 126 54 | 27.58 |
| 312—311 | 1,150.2 | 189 56 | 27.77 | 346—348 | 1,585.9 | 343 53 | ........ |
| 311—313 | 1,154.9 | 329 32 | ........ | 348—347 | 1,016.7 | 196 40 | 25.58 |
| 313—312 | 796.9 | 80 03 | 29.49 | 347—350 | 1,759.4 | 332 45 | ........ |
| 312—314 | 1,074.2 | 301 28 | ........ | 350—348 | 1,246 0 | 118 16 | 25.82 |
| 314—313 | 710.7 | 169 16 | 27.54 | 348—349 | 1,756.8 | 255 48 | ........ |
| 313—315 | 844.3 | 299 51 | ........ | 349—350 | 1,187.4 | 30 40 | 27.38 |
| 315—314 | 661.4 | 65 08 | 30.42 | 350—352 | 1,381.0 | 248 58 | ........ |
| 314—316 | 1,037.1 | 312 50 | ........ | 352—349 | 862.0 | 127 35 | ........ |
| 316—315 | 996.1 | 170 43 | 28.86 | 349—351 | 840.0 | 274 26 | ........ |
| 315—317 | 1,246.3 | 313 51 | ........ | 351—352 | 486.1 | 18 31 | 26.42 |

* Alexandria base line.

† Grand Bend base line.

TABLE 1.—*Tabulated results of tertiary triangulation of Red River survey, etc.*—Con't'd.

| Side. | Distance. | Azimuth. | Elevation. | Side. | Distance. | Azimuth. | Elevation. |
|---|---|---|---|---|---|---|---|
| | *Meters.* | ° ′ | *Meters.* | | *Meters.* | ° ′ | *Meters.* |
| 351—353 | 856.9 | 328 22 | ........ | 388—390 | 967.1 | 311 24 | ........ |
| 353—352 | 661.0 | 113 59 | 27.62 | 390—389 | 1,035.4 | 179 38 | 23.622 |
| 352—354 | 1,029.3 | 325 47 | ........ | 389—391 | 1,726.1 | 301 12 | ........ |
| 354—353 | 583.0 | 182 28 | 25.14 | 391—390 | 1,476.7 | 84 30 | ........ |
| 353—355 | 957.8 | 307 31 | ........ | 390—392 | 1,893.3 | 302 31 | ........ |
| 355—354 | 784.8 | 90 04 | 26.36 | 392—391 | 1,165.9 | 173 47 | ........ |
| 355—356 | 1,281.7 | 33 06 | ........ | 391—393 | 1,621.5 | 311 23 | ........ |
| 356—354 | 1,078.0 | 175 29 | ........ | 393—392 | 1,093.7 | 85 26 | 24.05 |
| 354—357 | 1,051.5 | 316 21 | ........ | 392—394 | 1,285.0 | 341 49 | ........ |
| 357—356 | 713.7 | 63 55 | 26.54 | 394—393 | 1,478.4 | 207 48 | ........ |
| 356—358 | 1,123.7 | 284 11 | ........ | 394—395 | 1,650.5 | 242 22 | ........ |
| 358—357 | 740.4 | 142 44 | 25.62 | 395—393 | 944.0 | 125 03 | 23.50 |
| 357—359 | 1,178.0 | 287 53 | ........ | 393—N. B | 1,618.9 | 340 43 | ........ |
| 359—358 | 710.0 | 71 20 | 26.60 | N. B.—395 | 1,014.2 | 193 34 | ........ |
| 358—360 | 1,057.0 | 285 56 | ........ | 395—396*a* | 1,151.8 | 339 55 | ........ |
| 360—359 | 621.3 | 146 25 | 25.38 | 396*a*—N. B | 640.5 | 98.37 | ........ |
| 360—362 | 806.5 | 218 22 | ........ | N. B.—S. B.* | 571.4 | 2 34 | ........ |
| 362—359 | 851.8 | 82 15 | 25.547 | S. B. 396*a* | 812 1 | 234 13 | ........ |
| 359—361 | 1,185.7 | 225 09 | ........ | 396*a*—397 | 1,565.1 | 215 34 | ........ |
| 361—362 | 721.5 | 359 43 | 26.14 | 397—395 | 1,319.8 | 81 40 | ........ |
| 362—364 | 959.1 | 231 45 | ........ | 397—398 | 913.4 | 315 37 | ........ |
| 364—361 | 767.4 | 99 35 | 24.38 | 398—396*a* | 1,669.0 | 68 11 | ........ |
| 361—363 | 849.2 | 238 50 | ........ | 398—398*a* | 1,121.6 | 178 40 | ........ |
| 363—364 | 568.1 | 356 58 | 26.45 | 398*a*—397 | 771.3 | 52 36 | 22.61 |
| 364—364*a* | 585.5 | 243 42 | ........ | 397—399 | 1,237.4 | 194 14 | ........ |
| 364*a*—363 | 634.7 | 119 02 | ........ | 399—398*a* | 793.2 | 337 09 | ........ |
| 364*a*—366 | 654.3 | 217 52 | ........ | 398*a*—400 | 660.0 | 195 24 | ........ |
| 366—363 | 979.1 | 77 42 | 26.93 | 400—399 | 492.5 | 101 05 | 22.84 |
| 363—365 | 846.7 | 207 33 | ........ | 399—401 | 844.7 | 230 19 | ........ |
| 365—366 | 782.9 | 313 49 | ........ | 401—400 | 655.7 | 14 44 | 22.70 |
| 366—366*a* | 1,060.8 | 182 04 | ........ | 400—402 | 935.4 | 246 45 | ........ |
| 366*a*—365 | 795.1 | 49 20 | 24.70 | 402—401 | 741.6 | 110 55 | ........ |
| 365—367 | 1,393.5 | 189 54 | ........ | 401—403 | 954.2 | 242 53 | ........ |
| 367—366*a* | 928.6 | 336 58 | ........ | 403—402 | 717.0 | 12 38 | ........ |
| 366*a*—368 | 1,673.4 | 197 25 | ........ | 402—404 | 939.8 | 270 20 | ........ |
| 368—367 | 1,139.1 | 49 21 | 24.90 | 404—403 | 1,053.8 | 132 00 | ........ |
| 367—369 | 1,832.1 | 195 27 | 25.73 | 403—405 | 1,345.7 | 246 21 | ........ |
| 369—368 | 1,090.7 | 339 50 | 26.41 | 405—404 | 1,323.8 | 19 52 | ........ |
| 368—370 | 1,364.7 | 193 03 | ........ | 404—406 | 1,303.9 | 240 19 | ........ |
| 370—369 | 749.3 | 65 57 | ........ | 406—405 | 908.0 | 131 20 | ........ |
| 369—371 | 994.6 | 210 51 | ........ | 405—407 | 896.0 | 277 21 | ........ |
| 371—370 | 575.4 | 342 23 | ........ | 407—406 | 527.3 | 23 06 | ........ |
| 370—372 | 546.9 | 266 29 | ........ | 406—408 | 923.2 | 243 59 | ........ |
| 372—371 | 885.2 | 125 34 | 25.19 | 408—407 | 627.8 | 97 19 | 21.01 |
| 371—374 | 1,375.4 | 273 35 | ........ | 407—409 | 991.4 | 237 58 | ........ |
| 374—372 | 781.0 | 56 41 | ........ | 409—408 | 643.7 | 19 46 | 21.77 |
| 372—373 | 1,026.0 | 195 04 | ........ | 408—410 | 961.8 | 269 55 | ........ |
| 373—374 | 681.5 | 325 31 | ........ | 410—409 | 958.4 | 129 05 | ........ |
| 374—376 | 1,215.0 | 195 22 | ........ | 409—411 | 791.5 | 257 20 | ........ |
| 376—373 | 934.3 | 49 15 | ........ | 411—410 | 778.2 | 2 05 | ........ |
| 373—375 | 1,431.5 | 194 33 | ........ | 410—412† | 893.2 | 248 01 | ........ |
| 375—376 | 850.5 | 335 49 | 27.92 | 412—411 | 914.6 | 119 01 | ........ |
| 376—378 | 1,103.2 | 202 44 | ........ | 411—413 | 925.3 | 244 15 | ........ |
| 378—375 | 811.6 | 72 41 | ........ | 413—412 | 846.3 | 2 16 | 20.01 |
| 375—377 | 1,123.3 | 213 08 | ........ | 412—414 | 1,421.8 | 215 50 | ........ |
| 377—378 | 717.3 | 347 03 | 29.89 | 414—413 | 855.9 | 68 59 | ........ |
| 377—379 | 718.9 | 236 05 | ........ | 413—415 | 1,478.6 | 215 21 | ........ |
| 379—378 | 1,183.3 | 21 37 | 24.23 | 415—414 | 900.9 | 3 35 | 21.37 |
| 378—380 | 1,899.6 | 234 19 | ........ | 414—416 | 1,448.0 | 220 46 | ........ |
| 380—379 | 1,107.3 | 89 37 | 25.06 | 416—415 | 910.8 | 77 28 | ........ |
| 379—381 | 1,857.6 | 235 16 | ........ | 415—417 | 1,394.9 | 197 17 | ........ |
| 381—380 | 1,131.7 | 21 45 | ........ | 417—416 | 1,229.6 | 337 17 | 19.78 |
| 380—282 | 1,751.6 | 245 08 | ........ | 416—418 | 1,486.2 | 197 10 | ........ |
| 382—381 | 1,211.5 | 105 03 | ........ | 418—417 | 956.9 | 72 37 | 20.62 |
| 381—383 | 1,995.1 | 225 16 | ........ | 417—419 | 1,330.5 | 219 25 | ........ |
| 383—382 | 1,736.3 | 8 12 | 23.31 | 419—418 | 745.3 | 354 43 | ........ |
| 382—384 | 1,368.6 | 223 04 | ........ | 418—420 | 1,136.8 | 206 38 | ........ |
| 384—383 | 994.5 | 136 17 | ........ | 420—419 | 639.7 | 64 39 | ........ |
| 384—385 | 1,792.0 | 192 56 | ........ | 419—421 | 1,125.7 | 207 01 | ........ |
| 385—383 | 1,496.7 | 46 38 | 24.39 | 421—420 | 731.9 | 354 47 | 19.29 |
| 383—386 | 1,705.3 | 260 30 | ........ | 420—422 | 1,133.0 | 206 42 | ........ |
| 386—385 | 953.6 | 141 30 | ........ | 422—421 | 641.7 | 63 48 | ........ |
| 385—387 | 1,579.8 | 286 59 | ........ | 421—423 | 1,134.8 | 203 33 | ........ |
| 387—386 | 960.6 | 72 45 | ........ | 423—422 | 706.9 | 350 48 | 19.53 |
| 386—388 | 1,344.0 | 299 45 | ........ | 422—424 | 1,321.9 | 222 21 | ........ |
| 388—387 | 984.0 | 165 19 | 23.845 | 424—423 | 1,036.8 | 77 46 | 19.49 |
| 387—389 | 1,116.6 | 299 52 | ........ | 423—425 | 1,641.5 | 221 42 | ........ |
| 389—388 | 820.5 | 61 09 | ........ | 425—424 | 1,008.9 | 4 29 | 20.11 |

*Barbin Landing base line.

†Murry Landing base line.

**Table 1.**—*Tabulated results of tertiary triangulation of Red River survey, etc.*—Cont'd.

| Side. | Distance. | Azimuth. | Elevation. | Side. | Distance. | Azimuth. | Elevation. |
|---|---|---|---|---|---|---|---|
| | *Meters.* | ° ′ | *Meters.* | | *Meters.* | ° ′ | *Meters.* |
| 424—434a* | 578.2 | 244 13 | ........ | 455—457 | 1,950.0 | 281 22 | ........ |
| 434a—425 | 874.2 | 149 39 | 20.30 | 457—456 | 1,508.7 | 66 44 | 18.24 |
| 425—426 | 1,186.4 | 291 30 | ........ | 456—458 | 1,092.1 | 283 16 | ........ |
| 426—424 | 1,313.6 | 64 13 | ........ | 458—457 | 906.1 | 200 53 | 19.22 |
| 426—427 | 1,107.4 | 223 55 | ........ | 458—460 | 1,513.1 | 261 35 | ........ |
| 427—425 | 1,906.9 | 79 02 | 20.11 | 460—457 | 1,330.0 | 118 02 | 19.70 |
| 428—426 | 1,909.6 | 289 53 | ........ | 457—459 | 1,150.9 | 262 17 | ........ |
| 428—427 | 1,774.9 | 144 37 | 21.44 | 459—460 | 780.4 | 357 33 | ........ |
| 427—429 | 2,591.2 | 289 04 | ........ | 459—461 | 1,254.5 | 303 44 | ........ |
| 429—428 | 1,542.9 | 67.06 | 19.06 | 461—460 | 1,013.3 | 85 18 | 19.16 |
| 428—430 | 1,631.6 | 279 26 | ........ | 460—462 | 1,710.8 | 297 57 | ........ |
| 430—429 | 888.0 | 167 47 | 21.69 | 462—461§ | 1,017.0 | 150 29 | 20.00 |
| 429—431 | 1,352.9 | 305 09 | ........ | 461—463 | 1,790.5 | 288 39 | ........ |
| 431—430 | 922.6 | 84 28 | ........ | 463—462 | 1,235.5 | 75 21 | 16.12 |
| 430—432 | 1,200.1 | 298 06 | ........ | 462—464 | 1,997.1 | 291 01 | ........ |
| 432—431 | 669.1 | 167 53 | 21.38 | 464—463 | 1,227.1 | 146 58 | 21.37 |
| 431—433 | 1,119.9 | 314 39 | ........ | 463—465 | 1,768.9 | 288 34 | ........ |
| 433—432 | 669.7 | 101 26 | 19.04 | 465—464 | 1,110.2 | 65 14 | ........ |
| 432—434 | 1,141.5 | 316 23 | ........ | 464—466 | 1,820.1 | 278 32 | ........ |
| 434—433 | 706.0 | 160 18 | 21.25 | 466—465 | 1,080.5 | 132 52 | ........ |
| 433—435 | 945.8 | 314 38 | ........ | 465—467 | 1,847.3 | 275 30 | ........ |
| 435—434 | 542.8 | 86 55 | 18.99 | 467—466 | 1,186.3 | 61 56 | ........ |
| 434—436 | 909.6 | 299 09 | ........ | 466—469 | 1,857.9 | 281 02 | ........ |
| 436—435 | 535.5 | 151 53 | 20.72 | 469—467 | 1,199.1 | 139 38 | ........ |
| 435—437 | 675.0 | 281 12 | ........ | 467—468 | 1,579.1 | 359 33 | ........ |
| 437—436 | 533.2 | 50 13 | 18.58 | 468—469 | 1,013.3 | 228 57 | ........ |
| 436—438 | 987.7 | 299 11 | ........ | 468—471 | 1,571.5 | 310 36 | ........ |
| 438—437 | 939.0 | 151 12 | 20.70 | 471—469 | 1,741.8 | 165 44 | ........ |
| 437—439 | 1,716.4 | 279 49 | ........ | 469—470 | 2,615.3 | 18 34 | ........ |
| 439—438 | 1,347.5 | 66 50 | 20.69 | 470—471 | 1,488.9 | 237 54 | ........ |
| 438—441 | 1,904.8 | 278 11 | ........ | 471—472 | 1,576.2 | 5 59 | ........ |
| 441—439 | 1,029.4 | 141 06 | 21.10 | 472—470 | 1,344.6 | 125 17 | ........ |
| 439—W. B | 961.2 | 354 49 | ........ | 470—472*a* | 1,099.4 | 266 43 | ........ |
| W. B.—441 | 581.1 | 254 24 | 20.93 | 472*a*—472‖ | 839.7 | 0 00 | ........ |
| 441—E. B | 433.9 | 23 19 | ........ | 471—473 | 2,162.6 | 329 25 | ........ |
| E. B.—W. B† | 457.4 | 121 59 | ........ | 473—472 | 1,298.4 | 103 05 | ........ |
| W. B.—442 | 757.7 | 303 02 | ........ | 472—475 | 2,175.4 | 324 55 | ........ |
| 442—441 | 574.4 | 172 27 | 20.26 | 475—473 | 1,486.1 | 180 33 | ........ |
| 441—443 | 996.4 | 306 28 | ........ | 473—474 | 1,483.2 | 37 28 | ........ |
| 443—442 | 726.2 | 91.48 | 18.80 | 474—475 | 940.2 | 289 10 | ........ |
| 442—444 | 1,222.5 | 330 53 | ........ | 474—476 | 1,528.3 | 345 05 | ........ |
| 444—443 | 1,053.3 | 187 08 | 19.51 | 476—475 | 1,268.5 | 202 57 | ........ |
| 443—445 | 1,481.9 | 332 31 | ........ | 475—477 | 1,643.9 | 340 39 | ........ |
| 445—444 | 864.1 | 108 40 | ........ | 477—476 | 1,107.7 | 110 14 | ........ |
| 444—446 | 907.9 | 324 33 | ........ | 476—478 | 2,049.0 | 334 31 | ........ |
| 446—445 | 547.5 | 212 16 | ........ | 478—477 | 1,475.0 | 186 08 | ........ |
| 445—447 | 906.8 | 306 31 | ........ | 477—479 | 2,386.5 | 327 47 | ........ |
| 447—446 | 1,023.9 | 94 18 | 20.96 | 479—478 | 1,533.0 | 111 07 | ........ |
| 446—448 | 1,352.0 | 308 42 | ........ | 478—480 | 2,300.9 | 339 18 | ........ |
| 448—447 | 769.5 | 177 28 | ........ | 480—479 | 1,714.5 | 201 04 | ........ |
| 448—448a | 575.7 | 272 56 | ........ | 479—481 | 1,842.2 | 333 33 | ........ |
| 448a—447 | 1,004.0 | 142 39 | 20.55 | 481—480 | 1,437.6 | 91 59 | ........ |
| 447—449 | 1,265.2 | 289 07 | ........ | 480—482 | 2,319.8 | 311 25 | ........ |
| 449—448a‡ | 700.8 | 56 47 | 18.53 | 482—481 | 1,515.6 | 168 28 | ........ |
| 448a—450 | 1,201.3 | 307 38 | ........ | 481—483 | 1,977.8 | 303 19 | ........ |
| 450—449 | 1,175.5 | 161 56 | 20.38 | 483—482 | 1,407.6 | 73 32 | ........ |
| 449—451 | 1,962.3 | 299 11 | ........ | 482—484 | 2,042.6 | 295 56 | ........ |
| 451—450 | 1,374.5 | 83 42 | ........ | 484—483 | 1,380.7 | 159 20 | ........ |
| 450—452 | 2,344.0 | 303 18 | ........ | 483—485 | 2,026.8 | 299 31 | ........ |
| 452—451 | 1,555.5 | 157 36 | ........ | 485—484 | 1,309.8 | 77 04 | ........ |
| 451—453 | 2,047.8 | 289 15 | ........ | 485—487 | 1,312.2 | 359 53 | ........ |
| 453—452 | 1,542.3 | 60 21 | ........ | 487—484 | 1,635.5 | 128 32 | ........ |
| 452—454 | 1,670.9 | 277 24 | ........ | 484—NE. B | 1,696.2 | 30 30 | ........ |
| 454—453 | 1,028.3 | 162 05 | 19.44 | NE. B—487 | 2,185.4 | 258 19 | ........ |
| 453—455 | 1,623.4 | 302 09 | ........ | 487—489 | 2,139.0 | 13 52 | ........ |
| 455—454 | 1,064.3 | 83 50 | ........ | 489—NE. B | 2,306.4 | 135 07 | ........ |
| 454—456 | 1,805.4 | 298 40 | ........ | 489—SW. B | 2,981.8 | 95 00 | ........ |
| 456—455 | 1,112.7 | 151 47 | 20.02 | SW. B—NE. B¶ | 1,921.8 | 224 21 | ........ |

* Larto Landing base line.
† Black River base line.
‡ Red Light Landing base line.
§ Bayou Cocodrie base line.
‖ Black Hawk Landing base.
¶ Lum Point base line (U. S. C. & G. Survey).

**Note.**—One meter=3.280833 feet. Azimuth is measured from zero south in the direction clock hands move. To derive "true bearings" from azimuth: between 0° and 90° the azimuth itself is the southwest course; from 90° to 180°, subtract the azimuth from 180° and the remainder is the northwest course; from 180° to 270° the northeast course is azimuth minus 180°, and from 270° to 360° the southeast course is 360° minus the azimuth.

## HYPSOMETRY.

The comparative elevation of points from Delta, La., to Smithland, La., via Shreveport, has been ascertained by the method of precise leveling lately practiced on Mississippi River surveys. In brief, while instrumental errors (Tables *a b c*) have been determined and correction applied, every endeavor has been made to insure their entering the observation as the least factor possible. Each stretch has been duplicated in opposite direction by the same observer, and, as far as possible, under like favorable conditions. The instrument was shaded; work stopped during midday, except when cloudy; back and fore sights equal, and not over 100 meters; readings taken with bubble at center; and the discrepancy of accepted results between runs in opposite directions was almost invariably less than 5 millimeters X $\sqrt{\text{distance in kilometers}}$, the distance being counted *between benches* and not the distance run both ways; nor were the runs made short to keep the ordinate of error close to the origin in the curve of allowable error.

From Shreveport the precise levels ran along the river bank to the head of the lower river swamp country at Barbin Landing; thence the line crossed Avoyelles Prairie, ran along the bank of Bayou des Glaizes, crossed Atchafalaya River at Simmesport, and ended on Coast and Geodetic Survey P. B. M. XLV at Smithland, on the Mississippi River. The difference of closure of the entire loop—Smithland, Delta, Shreveport, Grand Bend, and back to Smithland—was +0.0216 meter. The length of the portion—Smithland to Delta—run by Coast and Geodetic Survey is 248.4 kilometers, and the remaining portion is 654 kilometers, measured along the path of the levels.

Table 2 gives the results of observations between temporary bench marks; they have been connected as a continuous line and the precise bench marks connected as side lines. Descriptions and elevations of precise bench marks are given in Table 3, and sketches of location shown in plates.

From Fulton, Ark., to Shreveport, La., elevations were obtained by using a wye level, as practiced on Missouri River surveys. This work having been done in the winter of 1886 and 1887, permanent marks have been established and check levels run. The lack of precise levels over this part of the river, as heretofore said, is somewhat atoned for by accurate wye levels well checked. Table 4 gives descriptions and elevations of bench marks, and sketches show their location.

From Shreveport to Atchafalaya elevations of triangulation stations and river section reference points were obtained by checked wye level connections to precise bench marks, except from Barbin Landing down only duplicate wye levels were run along the river. A connection from head of Bayou Cocodrie to Mississippi River Commission stone $\frac{14}{4}$ at Black Hawk Landing gave a difference of closure +0.017 meter, the distance run being about 75 kilometers. Duplicate wye levels between stations checked within 0.05 meter. Elevations of triangulation stations have been given in Table 1, and those of river section reference points are given with descriptions in Table 5. Below Shreveport there is scarcely any place where the distance between two benches of one form or another exceeds 1 kilometer.

## TABLE 2.—PRECISE LEVELS.

[Observers: T. C. Thomas, T. G. Rombauer, W. H. Polk, E. T. Washburn, E. J. Thomas, R. S. Buck, Alex. E. Kastl.]

### *Instrumental constants.*

### TABLE A.

| Kern level. | Pivot correction for a distance of 1 meter. | Date of determination. |
|---|---|---|
| | *Millimeter.* | |
| L. S., No. 1........ | +0.010 | Feb. 16, 1889 |
| L. S., No. 1........ | +0.018 | June 4, 1889 |
| L. S., No. 1........ | +0.021 | Oct. 17, 1889 |
| M. R. C., No. 1 .... | —0.016 | Feb. 16, 1889 |
| M. R. C., No. 1 .... | —0.006 | Oct. 17, 1889 |
| M. R. C., No. 2 .... | +0.014 | May 29, 1889 |
| M. R. C., No. 2 .... | +0.002 | Dec. 28, 1889 |
| L. S., No 1........ | +0.005 | Oct. 6, 1891 |
| L. S., No. 1........ | —0.001 | Oct. 8, 1891 |
| L. S., No. 1........ | +0.002 | Jan. 20, 1892 |

*Instrumental constants.*—Continued.

### TABLE B.

| Bubble tube. | Value one division for a distance of 1 meter. | Date of determination. |
|---|---|---|
| | *Millimeter.* | |
| No. 4 | 0.016 | Feb. 16, 1889 |
| No. 4 | 0.016 | June 4, 1889 |
| No. 4 | 0.022 | Oct. 18, 1889 |
| No. 1 | 0.013 | Feb. 16, 1889 |
| No. 1 | 0.008 | July 5, 1889 |
| No. 1 | 0.014 | Oct. 18, 1889 |
| No. 2 | 0.015 | June 4, 1889 |
| No. 2 | 0.021 | Dec. 28, 1889 |
| No. 4 | 0.017 | Oct. 8, 1891 |
| No. 4 | 0.018 | Jan. 20, 1892 |
| No. 4 | 0.017 | Jan. 21, 1892 |
| No. 4 | 0.016 | Jan. 21, 1892 |

### TABLE C.

| Rod. | Length of 1 meter on rod. | Correction for spur. |
|---|---|---|
| | *Millimeters.* | *Millimeters.* |
| II | *999.866 | +47.5 |
| IV | *999.890 | +48.2 |
| XII | †999.973 | −50.1 |
| XV | †1,000.053 | −55.6 |
| XVI | †1,000.011 | −55.9 |

* Mean of Lake Survey and Mississippi River Commission determinations. See Mississippi River Commission report, 1881, p. 51.

† As determined by the Mississippi River Commission. See Chief of Engineers' Report, 1884, p. 2,464.

## *Tabulated results.*

### DELTA, LA., TO SHREVEPORT LA.

| Bench. | Distance— | | Difference of elevation. | | | Observer. |
|---|---|---|---|---|---|---|
| | Between bench marks. | From Delta. | West. | East. | Mean. | |
| | *Kilometers.* | *Kilometers.* | *Meters.* | *Meters.* | *Meters.* | |
| C. and G. Survey, P. B. M., No. 215 | | | | | | |
| C. and G. survey, △ SW. base | 0.1 | 0.1 | { − 1.2435 }<br>{ − 1.2459 } | − 1.2496 | − 1.2463 | T. T. and R. |
| T. B. M. 1 | 1.9 | 2.0 | − 0.0290 | − 0.0231 | − 0.0260 | R. |
| 2 | 1.2 | 3.2 | − 0.0433 | − 0.0418 | − 0.0425 | T. T. |
| 3 | 0.8 | 4.0 | + 0.2754 | + 0.2792 | + 0.2773 | T. T. |
| 4 | 2.0 | 6.0 | − 1.1491 | − 1.1525 | − 1.1508 | R. |
| 5 | 2.2 | 8.2 | + 0.6403 | + 0.6367 | + 0.6385 | T. T. |
| 6 | 2.7 | 10.9 | − 0.1209 | − 0.1312 | − 0.1260 | R. |
| 7 | 2.1 | 13.0 | + 0.7388 | + 0.7412 | + 0.7400 | T. T. |
| 8 | 3.5 | 16.5 | − 2.0106 | − 2.0072 | − 2 0089 | R. |
| 9 | 2.3 | 18.8 | − 0.3586 | − 0.3553 | − 0.3569 | T. T. |
| 10 | 2.4 | 21.2 | + 1.5064 | + 1.5116 | + 1.5090 | R. |
| 11 | 3.2 | 24.4 | − 0.3484 | − 0.3375 | − 0.3429 | T. T. |
| 11½ | 1.7 | 26.1 | + 1.8159 | + 1.8220 | + 1.8190 | R. |
| 12 | 1.4 | 27.5 | − 3.4498 | − 3.4450 | − 3.4474 | R. |
| 13 | 2.1 | 29.6 | − 1.0458 | − 1.0384 | − 1.0421 | T. T. |
| 14 | 1.7 | 31.3 | + 0.3248 | + 0.3317 | + 0.3282 | T. T. |
| 15 | 1.2 | 32.5 | + 2.7457 | + 2.7507 | + 2.7482 | T. T. |
| 16 | 1.8 | 34.3 | − 0.6563 | − 0.6508 | − 0.6535 | R. |
| 17 | 1.6 | 35.9 | − 0.0514 | − 0.0456 | − 0.0485 | R. |
| 18 | 2.0 | 37.9 | + 0.3648 | + 0.3739 | + 0.3693 | T. T. |
| 19 | 2.2 | 40.1 | − 0.4186 | − 0.4273 | − 0.4229 | T. T. |
| 20 | 1.7 | 41.8 | + 0.0799 | + 0.0840 | + 0.0819 | R. |
| 21 | 2.1 | 43.9 | − 1.7118 | − 1.7048 | − 1.7083 | T. T. |

### *Tabulated results*—Continued.

### DELTA, LA., TO SHREVEPORT, LA.—Continued.

| Bench. | Distance— | | Difference of elevation. | | | Observer. |
|---|---|---|---|---|---|---|
| | Between bench marks. | From Delta. | West. | East. | Mean. | |
| | *Kilometers.* | *Kilometers.* | *Meters.* | *Meters.* | *Meters.* | |
| T. B. M. 22 | 1.8 | 45.7 | + 1.7197 | + 1.7173 | + 1.7185 | R. |
| 23 | 2.2 | 47.9 | + 0.3301 | + 0.3258 | + 0.3280 | T. T. |
| 24 | 2.9 | 50.8 | — 0.4074 | — 0.4001 | — 0.4037 | R. |
| 25 | 1.6 | 52.4 | + 0.4650 | + 0.4641 | + 0.4645 | T. T. |
| 26 | 2.1 | 54.5 | + 0.9320 | + 0.9403 | + 0.9361 | R. |
| 27 | 1.0 | 55.5 | + 1.1013 | + 1.0995 | + 1.1004 | T. T. |
| 28 | 1.5 | 57.0 | + 1.7522 | + 1.7571 | + 1.7546 | T. T. |
| 29 | 1.7 | 58.7 | — 2.7615 | — 2.7601 | — 2.7608 | R. |
| 30 | 2.1 | 60.8 | — 0.5914 | — 0.5997 | — 0.5955 | R. |
| 31 | 1.3 | 62.1 | + 1.4792 | + 1.4820 | + 1.4806 | T. T. |
| 32 | 2.3 | 64.4 | — 1.2130 | — 1.2044 | — 1.2087 | R. |
| 33 | 2.1 | 66.5 | — 0.1439 | — 0.1415 | — 0.1427 | T. T. |
| 34 | 2.8 | 69.3 | — 0.0698 | — 0.0673 | — 0.0686 | R. |
| 35 | 3.4 | 72.7 | — 1.6697 | — 1.6695 | — 1.6696 | T. T. |
| 36 | 1.9 | 74.6 | — 0.2831 | — 0.2946 | — 0.2888 | T. T. |
| 37 | 2.5 | 77.1 | — 0.8820 | — 0.8788 | — 0.8804 | R. |
| 38 | 2.5 | 79.6 | + 1.5919 | + 1.5988 | + 1.5953 | T. T. |
| 39 | 2.7 | 82.3 | — 0.8871 | — 0.8821 | — 0.8846 | R. |
| 40 | 3.3 | 85.6 | + 0.6488 | + 0.6430 | + 0.6459 | T. T. |
| 41 | 2.4 | 88.0 | — 1.0122 | — 1.0138 | — 1.0130 | R. |
| 42 | 2.8 | 90.8 | — 3.0558 | — 3.0450 | — 3.0504 | T. T. |
| 42½ | 2.6 | 93.4 | — 0.2879 | — 0.2909 | — 0.2894 | R. |
| 43 | 1.6 | 95.0 | + 1.0882 | + 1.0860 | + 1.0871 | R. |
| 44 | 2.6 | 97.6 | — 0.0142 | — 0.0197 | — 0.0170 | T. T. |
| 45 | 3.0 | 100.6 | — 2.4375 | — 2.4376 | — 2.4376 | R. |
| 46 | 2.2 | 102.8 | + 1.2376 | + 1.2404 | + 1.2390 | T. T. |
| 47 | 2.7 | 105.5 | + 1.7872 | + 1.7870 | + 1.7871 | R. |
| 48 | 1.7 | 107.2 | + 0.3239 | + 0.3245 | + 0.3242 | T. T. and P. |
| 49 | 3.2 | 110.4 | — 0.9294 | — 0.9215 | — 0.9255 | R. |
| 50 | 3.2 | 113.6 | + 0.0063 | + 0.0149 | + 0.0106 | T. T. |
| 51 | 2.0 | 115.6 | + 2.5830 | + 2.5825 | + 2.5827 | R. |
| 52 | 2.8 | 118.4 | — 0.4022 | — 0.3925 | — 0.3974 | T. T. |
| 53 | 1.7 | 120.1 | + 6.6276 | + 6.6228 | + 6.6252 | T. T. |
| 54 | 4.2 | 124.3 | + 6.8931 | + 6.8849 | + 6.8890 | R. |
| 55 | 1.7 | 126.0 | — 6.7993 | — 6.7983 | + 6.7988 | T. T. |
| 56 | 2.3 | 128.3 | — 0.8044 | — 0.7988 | — 0.8016 | R. |
| 57 | 2.0 | 130.3 | + 1.9239 | + 1.9144 | + 1.9191 | T. T. |
| 58 | 0.9 | 131.2 | — 1.7010 | — 1.6982 | — 1.6996 | T. T. |
| 59 | 2.0 | 133.2 | + 2.4184 | + 2.4180 | + 2.4182 | R. |
| 60 | 1.5 | 134.7 | +13.8907 | +13.8929 | +13.8918 | P. |
| 61 | 1.4 | 136.1 | —10.2144 | —10.2141 | —10.2143 | W. |
| 62 | 1.9 | 138.0 | +14.1808 | +14.1797 | +14.1802 | R. |
| 63 | 2.4 | 140.4 | + 8.2597 | + 8.2572 | + 8.2585 | W. |
| 64 | 2.6 | 143.0 | — 4.0721 | — 4.0681 | — 4.0701 | R. |
| 65 | 2.9 | 145.9 | —15.7384 | —15.7362 | —15.7373 | W. |
| 66 | 7.0 | 152.9 | + 8.2665 | + 8.2655 | + 8.2660 | R. |
| 67 | 1.3 | 154.2 | — 3.4797 | — 3.4812 | — 3.4804 | W. |
| 68 | 1.7 | 155.9 | + 2.9036 | + 2.8986 | + 2.9011 | R. |
| 69 | 3.4 | 159.3 | +18.7667 | +18.7610 | +18.7638 | W. |
| 70 | 3.6 | 162.9 | +10.9680 | +10.9710 | +10.9695 | R. |
| 71 | 2.0 | 164.9 | +18.4824 | +18.4837 | +18.4831 | W. |
| 72 | 2.6 | 167.5 | —17.2477 | —17.2458 | —17.2467 | R. |
| 73 | 3.8 | 171.3 | + 7.7626 | + 7.7599 | + 7.7612 | R. |
| 74 | 2.5 | 173.8 | +15.5714 | +15.5732 | +15.5723 | W. |
| 75 | 2.9 | 176.7 | — 5.1150 | — 5.1142 | — 5.1146 | R. |
| 76 | 1.2 | 177.9 | +10.3824 | +10.3864 | +10.3844 | W. |
| 77 | 3.4 | 181.3 | — 8.2878 | — 8.2813 | — 8.2845 | R. |
| 78 | 1.8 | 183.1 | + 8.2109 | + 8.2083 | + 8.2096 | W. |
| 79 | 2.8 | 185.9 | — 3.2217 | — 3.2159 | — 3.2188 | R. |
| 80 | 2.5 | 188.4 | + 4.8203 | + 4.8244 | + 4.8223 | W. |
| 81 | 3.6 | 192.0 | + 1.9307 | + 1.9302 | + 1.9304 | R. |
| 82 | 2.9 | 194.9 | — 6.3545 | — 6.3479 | — 6.3512 | W. |
| 83 | 3.1 | 198.0 | —22.8284 | —22.8219 | —22.8251 | R. |
| 84 | 2.6 | 200.6 | — 0.3138 | — 0.3101 | — 0.3119 | W. |
| 85 | 2.7 | 203.3 | — 9.8658 | — 9.8625 | — 9.8641 | R. |
| 86 | 3.3 | 206.6 | — 3.2188 | — 3.2086 | — 3.2137 | W. |
| 87 | 3.0 | 209.6 | — 2.3510 | — 2.3517 | — 2.3513 | R. |
| 88 | 2.1 | 211.7 | + 3.5168 | + 3.5177 | + 3.5172 | W. |
| 89 | 2.8 | 214.5 | + 2.1946 | + 2.1947 | + 2.1946 | R. |
| 90 | 3.4 | 217.9 | — 6.7964 | — 6.7934 | — 6.7949 | W. |
| 91 | 2.9 | 220.8 | +18.4599 | +18.4579 | +18.4589 | R. |
| 92 | 1.5 | 222.3 | + 2.3616 | + 2.3652 | + 2.3634 | W. |
| 93 | 1.3 | 223.6 | — 7.9681 | — 7.9677 | — 7.9679 | R. |
| 94 | 1.8 | 225.4 | —13.6065 | —13.6030 | —13.6047 | R. |

### *Tabulated results*—Continued.

### DELTA, LA., TO SHREVEPORT, LA.—Continued.

| Bench. | Distance— |  | Difference of elevation. |  |  | Observer. |
|---|---|---|---|---|---|---|
|  | Between bench marks. | From Delta. | West. | East. | Mean. |  |
|  | *Kilometers.* | *Kilometers.* | *Meters.* | *Meters.* | *Meters.* |  |
| T. B. M. 95 | 1.6 | 227.0 | — 7.3752 | — 7.3703 | — 7.3728 | W. |
| 96 | 1.5 | 228.5 | + 5.9796 | + 5.9758 | + 5.9777 | R. |
| 97 | 1.1 | 229.6 | —11.0220 | —11.0254 | —11.0237 | R. |
| 98 | 0.9 | 230.5 | — 5.0622 | — 5.0645 | — 5.0633 | W. |
| 99 | 2.9 | 233.4 | + 8.8277 | + 8.8309 | + 8.8293 | R. |
| 100 | 1.9 | 235.3 | + 0.6971 | + 0.6932 | + 0.6951 | W. |
| 101 | 2.8 | 238.1 | + 7.0439 | + 7.0373 | + 7.0406 | R. |
| 102 | 2.1 | 240.2 | + 5.4396 | + 5.4447 | + 5.4421 | W. |
| 103 | 2.2 | 242.4 | — 3.1581 | — 3.1545 | — 3.1563 | R. |
| 104 | 1.5 | 243.9 | — 7.8013 | — 7.8000 | — 7.8007 | W. |
| 105 | 2.2 | 246.1 | + 8.8799 | + 8.8894 | + 8.8846 | W. |
| 106 | 2.6 | 248.7 | + 6.8795 | + 6.8837 | + 6.8816 | R. |
| 107 | 3.8 | 252.5 | + 6.3187 | + 6.3119 | + 6.3153 | R. |
| 108 | 2.1 | 254.6 | —16.6279 | —16.6341 | —16.6310 | W. |
| 109 | 1.0 | 255.6 | — 9.0705 | — 9.0687 | — 9.0696 | P. |
| 110 | 3.0 | 258.6 | + 0.6333 | + 0.6413 | + 0.6373 | R. |
| 111 | 1.4 | 260.0 | — 2.9451 | — 2.9431 | — 2.9441 | W. |
| 112 | 3.4 | 263.4 | + 0.5331 | + 0.5272 | + 0.5302 | R. |
| 113 | 2.4 | 265.8 | + 0.0883 | + 0.0831 | + 0.0857 | W. |
| 114 | 2.8 | 268.6 | + 0.8209 | + 0.8173 | + 0.8191 | R. |
| 115 | 1.2 | 269.8 | — 0.0685 | — 0.0632 | — 0.0658 | E. T. |
| 116 | 1.4 | 271.2 | + 5.1210 | + 5.1187 | + 5.1198 | R. |

### SHREVEPORT, LA., TO GRAND BEND, LA.

| Bench. | Distance— |  | Difference of elevation. |  |  | Observer. |
|---|---|---|---|---|---|---|
|  | Between bench marks. | From Shreveport. | South. | North. | Mean. |  |
|  | *Kilometers.* | *Kilometers.* | *Meters.* | *Meters.* | *Meters.* |  |
| T. B. M. 117 | 2.0 | 2.0 | — 3.5870 | — 3.5826 | — 3.5848 | E. T. |
| 118 | 2.8 | 4.8 | — 1.2191 | — 1.2226 | — 1.2209 | E. T. |
| 119 | 2.3 | 7.1 | + 0.6359 | + 0.6432 | + 0.6396 | R. |
| 120 | 1.8 | 8.9 | — 1.0273 | — 1.0317 | — 1.0295 | E. T. |
| 121 | 2.5 | 11.4 | — 0.4612 | — 0.4582 | — 0.4597 | E. T. |
| 122 | 1.6 | 13.0 | + 0.7091 | + 0.7036 | + 0.7063 | R. |
| 123 | 2.3 | 15.3 | — 1.1094 | — 1.1035 | — 1.1065 | R. |
| 124 | 2.0 | 17.3 | — 1.8361 | — 1.8362 | — 1.8361 | W. |
| 125 | 2.3 | 19.6 | — 0.7537 | — 0.7507 | — 0.7522 | E. T. |
| 126 | 2.6 | 22.2 | + 0.7112 | + 0.7166 | + 0.7139 | R. |
| 127 | 1.7 | 23.9 | — 0.8750 | — 0.8724 | — 0.8737 | R. |
| 128 | 1.1 | 25.0 | + 0.5561 | + 0.5556 | + 0.5558 | E. T. |
| 129 | 2.1 | 27.1 | — 0.3437 | — 0.3430 | — 0.3433 | E. T. |
| 130 | 2.6 | 29.7 | + 0.7701 | + 0.7755 | + 0.7728 | R. |
| 131 | 2.9 | 32.6 | — 1.3116 | — 1.3084 | — 1.3100 | E. T. |
| 132 | 2.4 | 35.0 | — 0.5996 | — 0.6021 | — 0.6008 | R. |
| 133 | 2.1 | 37.1 | — 0.9909 | — 0.9859 | — 0.9884 | E. T. and P. |
| 134 | 2.1 | 39.2 | — 0.2141 | — 0.2184 | — 0.2163 | R. |
| 135 | 2.5 | 41.7 | — 0.9373 | — 0.9344 | — 0.9359 | R. |
| 136 | 2.2 | 43.9 | + 1.3214 | + 1.3233 | + 1.3223 | R. |
| 137 | 2.1 | 46.0 | — 0.1626 | — 0.1654 | — 0.1640 | R. |
| 138 | 1.6 | 47.6 | — 0.3640 | — 0.3617 | — 0.3628 | R. |
| 139 | 1.6 | 49.2 | + 0.5528 | + 0.5563 | + 0.5546 | R. |
| 140 | 1.2 | 50.4 | — 0.6924 | — 0.6967 | — 0.6945 | R. |
| 141 | 2.0 | 52.4 | — 0.7584 | — 0.7540 | — 0.7562 | R. |
| 142 | 1.3 | 53.7 | + 0.0290 | + 0.0339 | + 0.0315 | R. |
| 143 | 1.0 | 54.7 | — 0.0150 | — 0.0137 | — 0.0144 | R. |
| 144 | 1.9 | 56.6 | — 0.5093 | — 0.5094 | — 0.5094 | R. |
| 145 | 2.0 | 58.6 | — 0.5618 | — 0.5568 | — 0.5593 | R. |
| 146 | 1.7 | 60.3 | + 0.4103 | + 0.4060 | + 0.4081 | R. |
| 147 | 2.0 | 62.3 | — 1.6378 | — 1.6449 | — 1.6414 | R. |
| 148 | 1.4 | 63.7 | + 0.9505 | + 0.9540 | + 0.9523 | R. |
| 149 | 1.5 | 65.2 | + 0.2702 | + 0.2738 | + 0.2720 | R. |
| 150 | 1.6 | 66.8 | + 0.3804 | + 0.3819 | + 0.3811 | R. |
| 151 | 2.0 | 68.8 | — 0.5514 | — 0.5575 | — 0.5545 | R. |
| 152 | 2.3 | 71.1 | — 0.5331 | — 0.5292 | — 0.5311 | R. |
| 153 | 2.0 | 73.1 | — 2.7110 | — 2.7066 | — 2.7088 | R. |
| 154 | 2.6 | 75.7 | + 0.4455 | + 0.4533 | + 0.4494 | R. and P. |
| 155 | 2.1 | 77.8 | + 0.0594 | + 0.0661 | + 0.0628 | R. |

*Tabulated results*—Continued.

SHREVEPORT, LA., TO GRAND BEND, LA.—Continued.

| Bench. | Distance— | | Difference of elevation. | | | Observer. |
|---|---|---|---|---|---|---|
| | Between bench marks. | From Shreveport | South. | North | Mean. | |
| | *Kilometers.* | *Kilometers.* | *Meters.* | *Meters.* | *Meters.* | |
| T. B. M. 156 | 2.0 | 79.8 | — 0.1494 | — 0.1437 | — 0.1465 | R. |
| 157 | 1.5 | 81.3 | + 0.6362 | + 0.6323 | + 0.6343 | R. |
| 158 | 1.6 | 82.9 | — 0.9580 | — 0.9545 | — 0.9562 | R. |
| 159 | 1.9 | 84.8 | — 0.1111 | — 0.1089 | — 0.1100 | R. |
| P. B. M. 57 | 1.1 | 85.9 | + 0.0463 | + 0.0470 | + 0.0466 | R. |
| T. B. M. 1 | 2.5 | 88.4 | + 1.7117 | + 1.6935 | + 1.7026 | R. |
| 2 | 2.0 | 90.4 | — 2.9657 | — 2.9662 | - 2.9659 | R. |
| 3 | 1.7 | 92.1 | + 0.0988 | + 0.0992 | + 0.0990 | R. |
| 4 | 1.3 | 93.4 | + 0.1063 | + 0.1021 | + 0.1042 | R. |
| 5 | 1.3 | 94.7 | — 0.6659 | — 0.6636 | — 0.6647 | R. |
| 6 | 1.0 | 95.7 | + 0.4940 | + 0.4971 | + 0.4956 | R. |
| 7 | 1.3 | 97.0 | — 0.8874 | — 0.8860 | — 0.8867 | R. |
| 8 | 1.1 | 98.1 | + 3.1280 | + 3.1330 | + 3.1305 | R. |
| 8½* | ........ | ........ | — 1.0310 | — 1.0703 | — 1.0506 | R. |
| 9 | 1.3 | 99.4 | — 1.1238 | — 1.1276 | — 1.1257 | R. |
| 10 | 0.6 | 100.0 | + 0.1780 | + 0.1758 | + 0.1769 | R. |
| 11 | 1.6 | 101.6 | + 1.4860 | + 1.4867 | + 1.4863 | R. |
| 12 | 1.1 | 102.7 | — 1.0917 | — 1.0927 | — 1.0922 | R. |
| 13 | 1.9 | 104.6 | — 0.5487 | — 0.5523 | — 0.5505 | R. |
| 14 | 0.9 | 105.5 | — 0.0716 | — 0.0690 | — 0.0703 | R. |
| 15 | 3.2 | 108.7 | — 1.1071 | — 1.1051 | — 1.1061 | R. |
| 16 | 1.1 | 109.8 | + 0.9904 | + 0.9875 | + 0.9889 | R. |
| 17 | 2.6 | 112.4 | — 0.7367 | — 0.7380 | — 0.7374 | R. |
| 18 | 1.1 | 113.5 | — 1.2009 | — 1.2024 | — 1.2016 | R. |
| 19 | 2.2 | 115.7 | + 0.4252 | + 0.4269 | + 0.4260 | R. |
| 20 | 1.3 | 117.0 | + 2.0737 | + 2.0770 | + 2.0754 | R. |
| 21 | 1.9 | 118.9 | — 2.3472 | — 2.3408 | — 2.3440 | R. |
| 22 | 1.1 | 120.0 | + 1.0931 | + 1.0956 | + 1.0943 | R. |
| 23 | 2.5 | 122.5 | — 1.3228 | — 1.3163 | — 1.3196 | R. |
| 24 | 1.4 | 123.9 | + 1.6387 | + 1.6450 | + 1.6419 | R. |
| 25* | ........ | ........ | + 0.3475 | + 0.3485 | + 0.3480 | R. |
| 26 | 2.6 | 126.5 | — 1.4153 | — 1.4087 | — 1.4120 | R. |
| 27 | 2.0 | 128.5 | — 2.4430 | — 2.4471 | — 2.4450 | R. |
| 28 | 1.3 | 129.8 | + 1.9920 | + 1.9970 | + 1.9945 | R. |
| 29 | 0.8 | 130.6 | — 0.1097 | — 0.1116 | — 0.1107 | R. |
| 30 | 2.0 | 132.6 | + 0.1537 | + 0.1558 | + 0.1547 | R. |
| 31 | 2.6 | 135.2 | — 2.1498 | — 2.1489 | — 2.1493 | R. |
| 32 | 1.6 | 136.8 | + 1.1788 | + 1.1809 | + 1.1799 | R. |
| 33 | 3.0 | 139.8 | — 2.1796 | — 2.1821 | — 2.1808 | R. |
| 34 | 1.7 | 141.5 | + 1.4369 | + 1.4391 | + 1.4380 | P. |
| 35 | 0.9 | 142.4 | — 0.1520 | — 0.1557 | — 0.1539 | P. |
| 36 | 2.7 | 145.1 | — 0.8610 | — 0.8688 | — 0.8649 | R. |
| 37 | 0.6 | 145.7 | — 0.0534 | — 0.0573 | — 0.0553 | R. |
| 38 | 2.9 | 148.6 | — 0.5915 | — 0.5886 | — 0.5900 | R. |
| 39 | 1.9 | 150.5 | — 0.0081 | — 0.0120 | — 0.0100 | R. |
| 40 | 1.8 | 152.3 | — 1.3064 | — 1.3106 | — 1.3085 | R. |
| 41 | 1.7 | 154.0 | + 0.9099 | + 0.9085 | + 0.9092 | R. |
| 42 | 1.1 | 155.1 | — 2.3534 | — 2.3549 | — 2.3541 | R. |
| 43 | 0.5 | 155.6 | + 2.4431 | + 2.4406 | + 2.4419 | R. |
| 44 | 1.0 | 156.6 | — 2.9926 | — 2.9967 | — 2.9946 | R. |
| 45 | 1.0 | 157.6 | +15.4896 | +15.4868 | +15.4882 | R. |
| 46 | 2.1 | 159.7 | —13.9252 | —13.9269 | —13.9260 | R. |
| 46½ | 1.6 | 161.3 | + 0.1084 | + 0.1083 | + 0.1084 | R. |
| 47 | 1.9 | 163.2 | — 0.3294 | — 0.3255 | — 0.3274 | R. |
| 47½ | 0.4 | 163.6 | + 0.2584 | + 0.2577 | + 0.2580 | R. |
| 48* | ........ | ........ | + 0.6965 | + 0.7085 | + 0.7025 | R. |
| 49 | 2.0 | 165.6 | — 1.0437 | — 1.0467 | — 1.0452 | R. |
| 50 | 1.8 | 167.4 | — 0.5747 | — 0.5744 | — 0.5745 | R. |
| 51 | 1.7 | 169.1 | — 1.1987 | — 1.2006 | — 1.1997 | R. |
| 52 | 1.6 | 170.7 | — 0.0206 | — 0.0269 | — 0.0237 | R. |
| 53 | 2.2 | 172.9 | + 0.4916 | + 0.4951 | + 0.4933 | R. |
| 54 | 1.5 | 174.4 | + 0.5229 | + 0.5216 | + 0.5222 | R. |
| 55 | 2.4 | 176.8 | — 2.5352 | — 2.5352 | — 2.5352 | R. |
| 56 | 0.5 | 177.3 | + 0.5690 | + 0.5680 | + 0.5685 | R. |
| 57 | 1.9 | 179.2 | — 0.4060 | — 0.4157 | — 0.4109 | R. |
| 58 | 1.5 | 180.7 | + 1.0861 | + 1.0831 | + 1.0846 | R. |
| 59 | 1.1 | 181.8 | — 0.1057 | — 0.1097 | — 0.1077 | R. |
| 60 | 1.0 | 182.8 | — 1.1602 | — 1.1643 | — 1.1622 | R. |
| 61 | 0.7 | 183.5 | + 0.7817 | + 0.7797 | + 0.7807 | R. |
| 62 | 1.1 | 184.6 | — 0.3137 | — 0.3087 | — 0.3112 | R. |
| 63 | 1.2 | 185.8 | — 0.2963 | — 0.2935 | — 0.2949 | R. |
| 64 | 1.2 | 187.0 | — 0.3020 | — 0.2994 | — 0.3007 | R. |
| 65 | 1.2 | 188.2 | + 0.2839 | + 0.2874 | + 0.2857 | R. |
| 66 | 1.1 | 189.3 | + 0.0490 | + 0.0523 | + 0.0507 | R. |

* River crossing.

## *Tabulated results*—Continued.

### SHREVEPORT, LA., TO GRAND BEND, LA.—Continued.

| Bench. | Distance— | | Difference of elevation. | | | Observer. |
|---|---|---|---|---|---|---|
| | Between bench marks. | From Shreveport. | South. | North. | Mean. | |
| | *Kilometers.* | *Kilometers.* | *Meters.* | *Meters.* | *Meters.* | |
| T. B. M. 67 | 1.6 | 190.9 | −1.7951 | −1.7941 | − 1.7946 | R. |
| 68 | 1.3 | 192.2 | +0.2122 | +0.2067 | + 0.2094 | R. |
| 68½ | 1.6 | 193.8 | +1.1181 | +1.1159 | + 1.1170 | R. |
| 69* | ........ | ........ | +1.9791 | +1.9806 | + 1.9798 | R. |
| 70 | 4.1 | 197.9 | −0.7993 | −0.8032 | − 0.8012 | R. |
| 71 | 3.8 | 201.7 | +0.0623 | +0.0568 | + 0.0595 | R. |
| 72 | 2.6 | 204.3 | +0.5761 | +0.5728 | + 0.5744 | R. |
| 73 | 1.6 | 205.9 | −0.6640 | −0.6679 | − 0.6659 | R. |
| 74 | 2.5 | 208.4 | −0.5605 | −0.5608 | − 0.5606 | R. |
| 75 | 1.8 | 210.2 | −0.2100 | −0.2104 | − 0.2102 | R. |
| 76 | 3.1 | 213.3 | −0.5656 | −0.5635 | − 0.5645 | R. |
| 77* | ........ | ........ | −0.9213 | −0.9223 | − 0.9218 | R. |
| 78 | 2.5 | 215.8 | −0.6132 | −0.6147 | − 0.6139 | R. |
| 79 | 2.4 | 218.2 | +0.1642 | +0.1690 | + 0.1666 | R. |
| 80 | 4.0 | 222.2 | +0.2331 | +0.2374 | + 0.2352 | R. |
| 81 | 2.3 | 224.5 | −1.0530 | −1.0591 | − 1.0560 | R. |
| 82 | 3.4 | 227.9 | −0.7438 | −0.7479 | − 0.7458 | R. |
| 83 | 5.1 | 233.0 | −0.5308 | −0.5303 | − 0.5305 | R. |
| 84 | 6.2 | 239.2 | +0.1612 | +0.1605 | + 0.1608 | R. |
| 85 | 1.9 | 241.1 | −2.1739 | −2.1680 | − 2.1709 | B. |
| 86 | 1.2 | 242.3 | +1.9671 | +1.9689 | + 1.9680 | B. |
| 87 | 1.6 | 243.9 | −0.7042 | −0.6997 | − 0.7019 | B. |
| 88 | 1.8 | 245.7 | −0.0447 | −0.0408 | − 0.0427 | B. |
| 89 | 1.7 | 247.4 | −0.1133 | −0.1112 | − 0.1122 | B. |
| 90 | 1.3 | 248.7 | −1.6176 | −1.6191 | − 1.6183 | B. |
| 91 | 1.7 | 250.4 | +1.7916 | +1.7921 | + 1.7918 | B. |
| 92 | 1.9 | 252.3 | −1.2314 | −1.2317 | − 1.2315 | B. |
| 93 | 0.9 | 253.2 | +1.2253 | +1.2281 | + 1.2267 | B. |
| 94 | 1.8 | 255.0 | −1.8699 | −1.8701 | − 1.8700 | B. |
| 95 | 1.3 | 256.3 | +1.1816 | +1.1827 | + 1.1821 | B. |
| P. B. M. 76 | 0.3 | 256.6 | −1.3693 | −1.3725 | − 1.3709 | B. |

* River crossing.

### GRAND BEND, LA., TO SMITHLAND, LA.

| Bench. | Distance— | | Difference of elevation. | | | Observer. |
|---|---|---|---|---|---|---|
| | Between bench marks. | From Grand Bend. | South. | North. | Mean. | |
| | *Kilometers.* | *Kilometers.* | *Meters.* | *Meters.* | *Meters.* | |
| P. B. M. 76 | ........ | ........ | ........ | ........ | ........ | |
| T. B. M. 1 | 2.32 | 2.32 | +0.8921 | +0.8849 | +0.8885 | |
| 2 | 0.63 | 2.95 | −0.2985 | −0.2962 | −0.2974 | K. |
| 3 | 1.26 | 4.21 | −0.7895 | −0.8021 | −0.7958 | K. |
| 4 | 1.55 | 5.76 | −0.0735 | −0.0803 | −0.0769 | K. |
| 5 | 1.62 | 7.38 | −0.0317 | −0.0363 | −0.0340 | K. |
| 6 | 1.85 | 9.23 | +0.6455 | +0.6419 | +0.6437 | K. |
| 7 | 1.28 | 10.51 | −0.9126 | −0.9105 | −0.9116 | K. |
| 8 | 1.67 | 12.18 | +0.3312 | +0.3295 | +0.3304 | K. |
| 9 | 1.74 | 13.92 | −0.9638 | −0.9700 | −0.9669 | K. |
| 10 | 1.70 | 15.62 | +0.0861 | +0.0862 | +0.0862 | K. |
| 11 | 1.43 | 17.05 | +0.0384 | +0.0324 | +0.0354 | K. |
| 12 | 1.39 | 18.44 | +0.9791 | +0.9672 | +0.9732 | K. |
| 13 | 1.24 | 19.68 | −1.9427 | −1.9459 | −1.9443 | K. |
| 14 | 1.10 | 20.78 | +0.3987 | +0.3942 | +0.3965 | K. |
| 15 | 0.86 | 21.64 | −0.8871 | −0.8860 | −0.8866 | K. |
| 16 | 1.44 | 23.08 | −0.0652 | −0.0683 | −0.0668 | K. |
| 17 | 0.86 | 23.94 | −0.1386 | −0.1420 | −0.1403 | K. |
| 18 | 0.79 | 24.73 | +0.9889 | +0.9868 | +0.9879 | K. |
| 19 | 1.25 | 25.98 | −0.3563 | −0.3576 | −0.3570 | K. |
| 20 | 0.49 | 26.47 | −0.1207 | −0.1234 | −0.1221 | K. |
| 21 | 1.29 | 27.76 | −0.0402 | −0.0459 | −0.0431 | K. |
| 22 | 0.82 | 28.58 | −0.0421 | −0.0430 | −0.0426 | K. |
| 23 | 0.94 | 29.52 | +0.0442 | +0.0436 | +0.0439 | K. |
| 24 | 0.74 | 30.26 | −0.3286 | −0.3323 | −0.3305 | K. |
| 25 | 0.82 | 31.08 | +0.1441 | +0.1389 | +0.1415 | K. |
| 26 | 0.80 | 31.88 | +0.0738 | +0.0742 | +0.0740 | K. |
| 27 | 0.47 | 32.35 | +0.0289 | +0.0251 | +0.0270 | K. |
| 28 | 1.20 | 33.55 | +0.2458 | +0.2447 | +0.2453 | K. |
| 29 | 0.75 | 34.30 | −0.2229 | −0.2249 | −0.2239 | K. |

GRAND BEND, LA., TO SMITHLAND, LA.—Continued.

| Bench. | Distance— | | Difference of elevation. | | | Observer. |
|---|---|---|---|---|---|---|
| | Between bench marks. | From Grand Bend. | South. | North. | Mean. | |
| | *Kilometers.* | *Kilometers.* | *Meters.* | *Meters.* | *Meters.* | |
| T. B. M. 30 | 1.09 | 35.39 | +0.0924 | +0.0934 | +0.0929 | K. |
| 31 | 0.76 | 36.15 | +0.0031 | +0.0051 | +0.0041 | K. |
| 32 | 0.91 | 37.06 | −0.0399 | −0.0437 | −0.0418 | K. |
| 33 | 0.93 | 37.99 | +0.2510 | +0.2554 | +0.2532 | K. |
| 34 | 1.01 | 39.00 | −0.1810 | −0.1862 | −0.1836 | K. |
| 35 | 0.64 | 39.64 | −0.1556 | −0.1580 | −0.1568 | K. |
| 36 | 0.16 | 39.80 | +0.0834 | +0.0830 | +0.0832 | K. |
| 37 | 1.30 | 41.10 | +0.0430 | +0.0428 | +0.0429 | K. |
| 38 | 1.02 | 42.12 | −0.2456 | −0.2409 | −0.2433 | K. |
| 39 | 1.40 | 43.52 | +0.0202 | +0.0212 | +0.0207 | K. |
| 40 | 1.13 | 44.65 | −0.3493 | −0.3525 | −0.3509 | K. |
| 41 | 1.44 | 46.09 | +0.2515 | +0.2469 | +0.2492 | K. |
| 42 | 1.32 | 47.41 | −0.5397 | −0.5397 | −0.5397 | K. |
| 43 | 1.33 | 48.74 | +0.0295 | +0.0297 | +0.0296 | K. |
| 45 | 1.11 | 49.85 | −0.8908 | −0.8957 | −0.8933 | K. |
| 46 | 0.96 | 50.81 | −0.4173 | −0.4178 | −0.4176 | K. |
| 47 | 0.85 | 51.66 | +1.0490 | +1.0462 | +1.0476 | K. |
| 48 | 1.60 | 53.26 | −0.3014 | −0.3041 | −0.3028 | K. |
| 49 | 0.60 | 53.86 | −0.5808 | −0.5826 | −0.5817 | K. |
| 50 | 1.60 | 55.46 | −1.5508 | −1.5477 | −1.5493 | K. |
| 51 | 1.03 | 56.49 | +7.6238 | +7.6227 | +7.6232 | K. |
| 52 | 1.13 | 57.62 | +0.2046 | +0.2000 | +0.2023 | K. |
| 53 | 1.34 | 58.96 | +0.4931 | +0.4910 | +0.4920 | K. |
| 54 | 0.92 | 59.88 | +0.7842 | +0.7862 | +0.7852 | K. |
| 55 | 1.26 | 61.14 | −0.1014 | −0.0990 | −0.1002 | K. |
| 56 | 0.80 | 61.94 | +0.5701 | +0.5728 | +0.5714 | K. |
| 57 | 1.39 | 63.33 | −2.4793 | −2.4846 | −2.4820 | K. |
| 58 | 1.61 | 64.97 | −0.8439 | −0.8404 | −0.8422 | K. |
| 59 | 2.01 | 66.98 | +0.8191 | +0.8180 | +0.8186 | K. |
| 60 | 1.03 | 68.01 | +0.0404 | +0.0347 | +0.0376 | K. |
| 61 | 2.59 | 70.60 | −0.3465 | −0.3416 | −0.3441 | K. |
| 62 | 0.82 | 71.42 | +0.2622 | +0.2617 | +0.2620 | K. |
| 63 | 0.28 | 71.70 | +0.5891 | +0.5911 | +0.5901 | K. |
| 64 | 2.05 | 73.75 | +1.3819 | +1.3810 | +1.3814 | K. |
| 64*a* | 1.40 | 75.15 | −9.4151 | −9.4097 | −9.4124 | K. |
| 65 | 0.89 | 76.04 | +2.2614 | +2.2620 | +2.2617 | K. |
| 66 | 1.32 | 77.36 | −0.3550 | −0.3525 | −0.3538 | K. |
| 67 | 1.26 | 78.62 | −0.9045 | −0.9063 | −0.9054 | K. |
| 68 | 1.25 | 79.87 | +0.7900 | +0.7945 | +0.7922 | K. |
| 69 | 1.14 | 81.01 | +0.0895 | +0.0902 | +0.0898 | K. |
| 70 | 0.98 | 81.99 | +0.0088 | +0.0104 | +0.0096 | K. |
| 71 | 1.20 | 83.19 | −2.5190 | −2.5184 | −2.5187 | K. |
| 72 | 2.08 | 85.27 | −1.0786 | −1.0799 | −1.0793 | K. |
| 73 | 1.24 | 86.51 | +1.3603 | +1.3600 | +1.3602 | K. |
| 73*a* | 1.02 | 87.53 | +0.8718 | +0.8611 | +0.8664 | K. |
| 74 | 0.08 | 87.61 | −0.2700 | −0.2700 | −0.2700 | K. |
| 75 | 1.22 | 88.83 | −0.4844 | −0.4858 | −0.4851 | K. |
| 76 | 1.67 | 90.50 | +0.3902 | +0.3856 | +0.3879 | K. |
| 78 | 2.65 | 93.15 | −0.5321 | −0.5239 | −0.5280 | K. |
| 79 | 1.33 | 94.48 | +0.0686 | +0.0666 | +0.0676 | K. |
| 80 | 1.18 | 95.66 | −0.1873 | −0.1906 | −0.1890 | K. |
| 81 | 1.58 | 97.24 | −0.2714 | −0.2703 | −0.2709 | K. |
| 82 | 1.70 | 98.94 | −0.2180 | −0.2121 | −0.2151 | K. |
| 83 | 1.19 | 100.13 | +0.0257 | +0.0259 | +0.0258 | K. |
| 84 | 1.39 | 101.52 | −0.1973 | −0.1931 | −0.1952 | K. |
| 85 | 1.02 | 102.54 | −0.1730 | −0.1692 | −0.1711 | K. |
| Rod Sta. 1 | 0.31 | 102.85 | −3.1003 | −3.1010 | −3.1007 | K. |
| Rod Sta. 2* | 0.30 | 103.15 | −1.2408 | −1.2424 | −1.2416 | K. |
| 86 | 0.09 | 103.24 | +4.9884 | +4.9887 | +4.9886 | K. |
| 87 | 1.78 | 105.02 | −0.1561 | −0.1563 | −0.1562 | K. |
| 89 | 2.52 | 107.54 | +0.2597 | +0.2584 | +0.2590 | K. |
| 90 | 0.62 | 108.16 | −0.8096 | −0.8079 | −0.8088 | K. |
| 91 | 1.38 | 109.54 | +1.0131 | +1.0136 | +1.0134 | K. |
| 92 | 1.00 | 110.54 | +0.1952 | +0.1943 | +0.1948 | K. |
| 93 | 0.64 | 111.18 | +0.0840 | +0.0804 | +0.0822 | K. |
| 94 | 1.00 | 112.18 | −0.1425 | −0.1455 | −0.1440 | K. |
| P. B. M. 93 | 0.48 | 112.66 | −0.0402 | −0.0419 | −0.0411 | K. |
| 94 | 0.49 | 113.15 | +0.2020 | +0.1989 | +0.2004 | K. |
| T. B. M. 95 | 2.37 | 115.52 | −0.2006 | −0.1938 | −0.1972 | K. |
| 96 | 0.93 | 116.45 | −0.2080 | −0.2070 | −0.2075 | K. |
| 97 | 2.05 | 118.50 | +0.3899 | +0.3862 | +0.3880 | K. |
| 98 | 1.64 | 120.14 | −0.1110 | −0.1150 | −0.1130 | K. |
| M. R. C. B. M. 1/3* | 1.26 | 121.40 | +0.7073 | +0.7055 | +0.7064 | K. |
| T. B. M. 99 | 1.20 | 122.60 | −1.9767 | −1.9729 | −1.9748 | K. |
| 101 | 2.12 | 124.72 | +0.0624 | +0.0644 | +0.0634 | K. |
| C. and G. S. B. M. XLV | 1.49 | 126.21 | +0.7877 | +0.7884 | +0.7880 | K. |

*River crossing.

### TABLE 3.—DESCRIPTIONS AND ELEVATIONS OF PRECISE BENCH MARKS FROM DELTA, LA., TO SMITHLAND, LA.

NOTE.—All bench-mark monuments, when not otherwise described, consist of pieces of limestone 46 centimeters square and 15 centimeters thick, marked $\overset{\text{U. S.}}{\underset{\text{B. M.}}{\circ}}$ with spherical-headed copper bolts leaded in upper faces, and buried 1.2 meters under ground, access being given through 12-centimeter iron pipes set on top. Each pipe has a cast-iron cover, fastened by a horizontal bolt through cap and pipe. The cap has a small boss and the letters $\overset{\text{U. S. E.}}{\underset{\text{B. M.}}{\circ}}$ raised on top. Elevations are expressed in meters above the Cairo datum and apply to the top of the bolt in the underground stone. Elevation of boss of pipe cap can be found in any case by adding 1.24 meters to elevation of copper bolt.

C. and G. S. P. B. M. 215: For description, see Report Chief of Engineers, 1885, page 2676. Elevation, 34.084.

P. B. M. 2: At northeast corner of the most easterly of the Vicksburg, Shreveport and Pacific Railroad section houses at Mound Station, Madison Parish, La. Bench is 0.8 meter south and 0.2 meter east of northeast corner of house. Elevation, 31.522.

P. B. M. 3: In northeast corner of yard of Mrs. N. Thomas, at California Station, Madison Parish, La., about 400 meters south of Vicksburg, Shreveport and Pacific Railroad Bridge No. 25. Elevation, 33.070.

P. B. M. 4: In southwest corner of yard around cabin, and opposite store at Barnes Station, Madison Parish, La.; 13.4 meters from southwest corner of cabin chimney, and 44 meters north of center of railroad siding. Elevation, 30.880.

P. B. M. 5: Hole in head of copper bolt leaded horizontally in south wall of court-house at Tallulah, Madison Parish, La. Bolt is 0.6 meter west of west side of main door and 0.55 meter above floor of gallery. Elevation, 34.163.

P. B. M. 6: Cross-cut on west end of iron door sill at south entrance of Tallulah court-house. It is nearly under P. B. M. 5. Elevation, 33.767.

P. B. M. 7: On east bank of Lake One, 57 meters north of east pier of Vicksburg, Shreveport and Pacific Railroad Bridge and in a southwesterly direction from Waddill's sawmill. Elevation, 29.743.

P. B. M. 8: At northwest corner of store at Quebec Station, Madison Parish, La. Store is 110 meters southwest from west end of railroad siding and 60 meters east of east end of railroad bridge over Bayou Dispute. Elevation, 29.064.

P. B. M. 9: On east bank of Tensas River, in a southeasterly direction from railroad bridge, and in direct range of second bent of east bridge approach, 8.7 meters south of center line of track. Elevation, 29.996.

P. B. M. 10: At Dallas, Madison Parish, La. Bench is 2.35 meters east of brick chimney of first cabin west of Tensas River, on north side of railroad track, and 4.1 meters north of center line of track. Elevation, 29.409.

P. B. M. 11: In northwest corner of yard of house occupied by section foreman at Waverly, Madison Parish, La. Bench is 55 meters south of center of railroad track, and 20.5 meters north of house, in continuation of west wall. Elevation, 30.118.

P. B. M. 12: On west bank of Bayou Maçon, near Vicksburg, Shreveport and Pacific Railroad Bridge. Bench is in direct range of the fourth bent of west bridge approach, 40 meters south of center of track, and 10.8 meters northeast of blazed locust. Elevation, 28.801.

P. B. M. 13: At Delhi, Richland Parish, La., in northwest corner of residence lot belonging to W. T. Insley. Bench is 27.3 meters south of center line of track, 20.4 meters east of Catholic church-yard fence, and 1 meter south and 1 meter east of northwest fence corner. Elevation, 34.927.

P. B. M. 14: At Carpenter Station, Richland Parish, La., in southeast corner of yard of cabin standing opposite railroad platform. Bench is 15.4 meters north of center of track, and 23.8 meters southeast of southeast corner of cabin. Elevation, 32.514.

P. B. M. 15: At Holly Ridge, Richland Parish, La., in yard of residence of W. F. Winstead; 23.4 meters south of front line of gallery; 1.8 meters west of main door to house, and 18.3 meters north of center line of track. Elevation, 32.089.

P. B. M. 16: In court-house yard at Rayville, Richland Parish, La. Bench, 0.8 meter west of northwest corner of "L" in court-house front, 0.9 meter north of north wall, and 61 meters south of center of track. Elevation, 30.662.

P. B. M. 17: Hole in head of copper bolt leaded in face of "L" of court-house front, Rayville, La.; 0.09 meter west of north door, and 0.4 meter above floor line. Elevation, 32.992.

P. B. M. 18: On east bank of Boeuf River, in a southeasterly direction from Vicksburg, Shreveport and Pacific Bridge; 70.6 meters south of center line of track, and in direct range of first bent east end of bridge approach; 12.5 meters from riv bank, and 200 meters northeast of house. Elevation, 30.573.

P. B. M. 19: At Girard, Richland Parish, La.; east side of yard of Mrs. Brashear; meters east and 4.5 meters south of southeast corner of brick chimney at east end house, and 26 meters south of center line of track. Elevation, 30.321.

P. B. M. 20: Hole in head of copper bolt leaded in east face of brick chimney east end of Mrs. Brashear's house at Girard, Richland Parish, La. Bolt is 0.3 met from north face of chimney and 1 meter above springing course. Elevation, 32.46

P. B. M. 21: In southeast corner of garden lying in a northwesterly direction fro railway platform at Crew Lake Station, Richland Parish, La. Bench is 4.5 mete west of southwest corner of store at Crew Lake, on line of front of store, and 2 meters north of center line of track. Elevation, 26.443.

P. B. M. 23: In northeast corner of yard on plantation of F. L. Whitehead at Gordon Station, Ouachita Parish, La. Bench is 14.7 meters north and 9.5 meters east northeast corner of brick chimney at east end of an L-shaped cabin in same yard bench. Elevation, 25.787.

P. B. M. 24: In grass plot south of round-house at Vicksburg, Shreveport and Pacific Shops, Monroe, Ouachita Parish, La. Bench is in southwest corner of plot, meters north of center line of track and 2.4 meters east of east wall of office building. Elevation, 27.994.

P. B. M. 25: Is cross-cut on northwest corner of iron-roller plate, set on granite ca of concrete pier, with sheet-iron casing at north side of east end of bridge, ove Ouachita River, at Monroe, Ouachita Parish, La. Elevation, 30.810.

P. B. M. 26: Is an arrow cross (+⟶) cut in granite capstone of concrete pier with sheet-iron casing at north side of west end of bridge, over Ouachita River, at Monroe. Elevation, 30.857.

P. B. M. 27: In northwest corner of court-house yard at Monroe. Bench is in line of oak trees parallel to court-house front and midway between two lines of oaks parallel to north wall, 45 meters west and 9 meters north of northwest corner of building. Elevation, 29.964.

P. B. M. 28: In northeast corner of yard of T. C. McLain, West Monroe, Onachita Parish, La., at southwest corner of Cotton and Natchitoches streets. Bench is 9.3 meters east of center line of McLain's house and 10 meters north of north face of brick chimney at east side of house. Elevation, 29.219.

P. B. M. 29: At northwest corner of section-house yard at Chênière Station, Ouachita Parish, La. Bench is 17.5 meters south of center line of track and 63.7 meters east of Vicksburg, Shreveport and Pacific pile bridge No. 181. Elevation, 33.494.

P. B. M. 30: At northwest corner of yard of C. C. Harris, Calhoun, Ouachita Parish, La. Bench is 18 meters west and 7.5 meters north of northwest corner of Harris's house, and 45 meters south of center of track. Elevation, 56.626.

P. B. M. 32: At Choudrant, Lincoln Parish, La., 1 meter east and 4.4 meters north of southeast corner of Farmers' Union office, and 66 meters north of center line of track. Elevation, 52.596.

P. B. M. 33: In court-house yard, Ruston, Lincoln Parish, La. Bench is 1.5 meters south and 1.5 meters west of southeast corner of brick building used as sheriff's office. at southwest corner of Louisiana and Vienna streets. Elevation, 102.030.

P. B. M. 34: Is 50 meters northwest of platform at Allen Green station, Lincoln Parish, La., 46 meters north of center line of track, 1 meter east of frame store, and 27 meters northeast of blazed oak. Elevation, 106.818.

P. B. M. 35: In northwest corner of yard of Mr. Madden, Simsboro, Lincoln Parish, La. Bench is 1 meter from street line, 1 meter from fence on west side of yard, and 24.5 meters from northwest corner of house. Elevation, 103.814.

P. B. M. 36: In southeast corner of section-house yard at Arcadia, Bienville Parish, La., 6 7 meters south and 6.5 meters east of southeast corner of the most easterly of four section houses; 24 meters north of center of track. Elevation, 118.649.

P. B. M. 37. In northeast corner of Colbert Hotel yard, Gibbsland Station, Bienville Parish, La. Bench is 1.3 meters south and 1.4 meters west of northeast fence corner, and 31.6 meters south of center of track. Elevation, 79.925.

P. B. M. 38: In northeast corner of gin yard at Taylor Station, Bienville Parish, La. Bench is 12.5 meters north and 8.3 meters east of northeast corner of gin, and 17.5 meters south of center of track. Elevation, 72.711.

P. B. M. 39: in southeast corner of yard of P. H. McCary, Dubberly, Webster Parish, La. Bench 1.1 meters north and 1 meter west of fence corner, and 11.8 meters from southeast corner of brick chimney at south side of house. Elevation, 84.194.

P. B. M. 40: In northwest corner of Mr. Allison's yard, Sibley, Webster Parish, La. Bench is 1.1 meters south and 0.8 meter east of fence corner, 28.8 meters south of center line of track, and 15 meters from northwest corner of house. Elevation, 63,783.

P. B. M. 41: On east bank of Bayou Dorcheat, near Vicksburg, Shreveport and

Pacific Bridge. Bench is in direct range of second bent of east bridge approach, 22 meters south of center of track, and 20.5 meters east of draw span of bridge. Elevation, 49.132.

P. B. M. 42: In northwest corner of field owned by D. B. Doyle, at Doyle Station, Webster Parish, La. Bench is 45 meters south of Farmer's Alliance Building, 30 meters southeast of southeast corner of Doyle's store, and directly southwest from station platform. Elevation, 74.221.

P. M. B. 43: In southwest corner of J. T. Edward's yard, Haughton, Bossier Parish, La. Bench is 11.6 meters south and 10.4 meters west of southwest corner of residence. Elevation, 78.346.

P. B. M. 44: In northeast corner of yard of Oliver Williams, Bodcau, Bossier Parish, La. Bench is 5.6 meters east and 4.5 meters north of northeast corner of residence and 24.3 meters south of center of track. Elevation, 68.274.

P. B. M. 45: Same as △ W. B. of Shreveport base line. On east side of Red River, opposite Shreveport, about 300 meters from Bossier end of Vicksburg, Shreveport and Pacific Bridge over Red River, and 20 meters south of track. Bench is in northwest corner of small field, where road from southeast turns northeast along track. Elevation, 58.370.

P. B. M. 46: In northwest corner of yard of the public building at Shreveport, La. Bench is 1.3 meters east and 0.5 meter south of fence corner, and 28 meters north of northwest corner of building. Elevation, 65.845.

P. B. M. 47: In southwest portion of field on Kincaid Place, left bank of Red River, Bossier Parish, La. Bench is 115 meters back of levee on river front, 50 meters east of bank of bayou, and 60 meters northwest from cabin standing east of bayou and back of levee. Elevation, 56.138.

P. B. M. 48: At Lotus Landing, right bank of Red River, Caddo Parish, La. Bench is in northwest corner of yard of Capt. Robson's store, 46.5 meters from river, 1.5 meters back of store, and 50 meters south of dwelling house just above the store. Elevation, 54.230.

P. B. M. 49: At bend in levee about 430 meters south of gin on Cash plantation, right bank of river, Caddo Parish, La. Bench is 137 meters from river, 83 meters northwest of bayou, and 3 meters north of thorn tree on outer side of levee. Elevation, 52.599.

P. B. M. 50: Near Caspiana Landing, right bank of river, Caddo Parish, La., on J. H. Hutchinson's plantation. Bench is 2.5 meters east of gin, 126 meters from river, and 40 meters south of public road. Elevation, 51.335.

P. B. M. 51: In southeast corner of Dr. T. Allison's yard, Campo Bello plantation, Caddo Parish, La., right bank. Bench is 97 meters from river, 19 meters north and 3.9 meters east of southeast corner of house, and about 300 meters southeast of gin. Elevation, 50.816.

P. B. M. 52: On Bonner's plantation, Caddo Parish, La., right bank. Bench is 8 meters north and 2 meters east of cabin occupied by S. Smith (colored), 183 meters from river, and 300 meters southwest of a gin standing at first bend of river to the left below Bear Point Landing. Elevation, 50.077.

P. B. M. 53: On Stringfellow's plantation, near Howard Post-office, Red River Parish, La., right bank of river. Bench is in southwest corner of yard of cabin occupied by S. Johnson (colored), 23.5 meters south and 6.8 meters west of cabin. Cabin stands 300 meters southwest of plantation house and 200 meters south of gin. It is the first cabin south of post-office. Elevation, 49.273.

P. B. M. 54: In yard of Thomas Bell, just below mouth of Loggy Bayou, on left bank of river. Bench is 10.4 meters north of residence and 45 meters from river bank. Elevation, 50.005.

P. B. M. 55: In southwest corner of lot owned by W. P. Scarborough, at East Point, Red River Parish, La. Bench is 16.5 meters from river, 3.5 meters south of James Foley's warehouse, and 0.9 meter from front fence of lot. Elevation, 49.391. Destroyed in 1892.

P. B. M. 56: On Crichton's plantation, Red River Parish, La., left bank of river. Bench is in southwest corner of yard around two cabins standing where river makes an abrupt turn to the right. Cabins are about 400 meters below Mr. Crichton's residence and 100 meters to left of the public road. Elevation, 48.164.

P. B. M. 57: In northwest corner of court-house yard at Coushatta, Red River Parish, La. Bench is 1 meter from north fence line, 1 meter from west fence line, and 33.2 meters from northwest corner of court house. Elevation, 46.489.

P. B. M. 58: In northwest corner of yard of Methodist church, at Coushatta, La. Bench is 0.8 meter from north fence line, 0.9 meter from west fence line, 31 meters from east fence line, and 7.9 meters from northwest corner of church. Elevation, 46.913.

P. B. M. 59: On Upper Brownsville plantation, Red River Parish, La., in northeast corner of garden back of a negro cabin standing about 600 meters southeast of Lake

End Landing and 300 meters from bank. Bench is 10 meters southeast of southeast corner of cabin. Elevation, 44.718.

P. B. M. 60: On property of George Johnson (colored) next below Boyce plantation, Natchitoches Parish, La., right bank. Property lies just above Old River and to left of public road to Campti. Bench is 1.8 meters from north line of residence and on line with front of gallery. Elevation, 43.112.

P. B. M. 61: In northwest corner of yard of S. O. Melancon, Le Vassar plantation, Natchitoches Parish, La., at lower end of Closs Point Bend, about 3 kilometers below Campti, La. Bench is 8.5 meters northeast of front line of gallery and 6.3 meters northwest of northwest line of house. Elevation, 42.385. Destroyed in 1892.

P. B. M. 62: In small yard adjoining Willow post-office building, Natchitoches Parish, La. Bench is 3.5 meters south of south line of post-office and 3 meters west of west line of post-office. Elevation, 42.461.

P. B. M. 63: In southwest corner of yard of H. P. Gallion, Natchitoches Parish, La., opposite lower end of Tiger Island, and on east bank of Fausse River just above where it branches. Bench is 39 meters west of west line of gallery of residence and 5.5 meters south of south line of residence. Elevation, 40.562.

P. B. M. 64: At St. Maurice, Winn Parish, La., in southeast corner of inclosure southeast of E. W. Tedlie's store, 0.8 meter northwest of northwest line of front gallery and 5.2 meters southwest of southwest line of store. Elevation, 39.005.

P. B. M. 65: On plantation of C. C. Dunn, Grant Parish, La., near a cabin standing 375 meters above Dunns Landing. Bench is 5.1 meters south of south wall of cabin and 8 meters east of east wall. Elevation, 38.109.

P. B. M. 66; On plantation of Dr. R. E. Jackson, Natchitoches Parish, La., about 1.5 kilometers below town of Montgomery and on right bank. Bench is in northeast corner of Dr. Jackson's yard, 31.6 meters east of east wall of house and 23.3 meters north of north wall. Elevation, 36.413.

P. B. M. 67: On J. A. William's plantation, at Buxtons Landing, Natchitoches Parish, La. Bench is 60 meters east of east wall of plantation house and 14 meters south of south wall. House stands 80 meters below mouth of Little River. Elevation, 34.297.

P. B. M. 68: On right bank, opposite dwelling house on plantation of Isaac McMills and about 6.4 kilometers above town of Colfax, La. Bench is referenced as follows: No. 1, blazed oak tree southwest of bench, 6 meters distant; No. 2, blazed oak northwest of bench, 11 meters distant; No. 3, △ 248 north of bench, 70 meters distant; △ 248 is on river bank 260 meters below mouth of small bayou. Elevation, 32.576.

P. B. M. 69: In northwest corner of court-house yard, at southeast corner of Second and Main streets, Colfax, Grant Parish, La. Bench is 8.4 meters north of north wall of court-house and 16.2 meters west of west wall. Elevation, 35.498.

P. B. M. 70: On plantation of Mrs. A. C. Deal, Grant Parish, La., about 2 kilometers above Fairmount post-office and opposite Deloges Rock. Bench is in southeast corner of yard on west side of Mrs. Deal's store, 5 meters south of south wall of store and 9.4 meters west of east wall. Elevation, 35.001.

P. B. M. 71: At Boyce, Rapides Parish, La., next to fence in field belonging to Mr. Boyce and at an angle of lane running back from warehouse along north side of town. Bench is 42 meters west of east wall of J. T. Carnahan's residence and 37.1 meters north of north wall. Elevation, 32.348.

P. B. M. 72: On Mr. Marye's plantation, Rapides Parish, La., about 5.6 kilometers below Rapides post-office. Bench is on small levee 0.7 meter northwest of intersection of levee with division fence between Marye's and Cruikshank's plantations, and 4 meters southeast of angle in levee where it changes its course from southwest to southeast. Elevation, 30.091.

P. B. M. 73: In south corner of court-house yard, corner of Lee and Second streets, Alexandria, La. Bench is 26.7 meters southwest of southwest wall of court-house and 21.3 meters southeast of southeast wall. Elevation, 28.642.

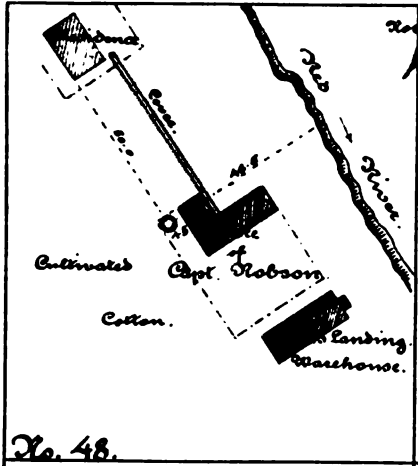
P. B. M. 74: In east corner of yard of Rapides Parish jail, Alexandria, La., on Lee street, between Fifth and Sixth streets. Bench is 3.2 meters southeast of southeast wall of jail and 10 meters northeast of northeast wall. Elevation, 27.795.

P. B. M. 75: On plantation of C. O. Harris, Rapides Parish, La,; right bank about 8 kilometers below Alexandria, La., and near a cabin standing 32 meters west of a point on levee which is 22.5 meters below bend in levee opposite and a little above Cannon's wood-yard. Bench is 6.3 meters north of north wall of cabin, 17.2 meters east of east wall, and 16 meters back of levee. Elevation, 28.274.

P. B. M. 76: Same as △ southwest base of Grand Bend base line, and is on Peart's plantation, Rapides Parish, La., on neck of Grand Bend. Bench is about midway on neck at side of fence dividing pasture and thicket, on thicket side. Elevation, 27.846.

P. B. M. 77: Near Jones Quarter Landing, Rapides Parish, La. It is about 300 meters below the landing, 10 meters south of parish road, 12 meters from base of

# Red River Survey. — T. B. M. —



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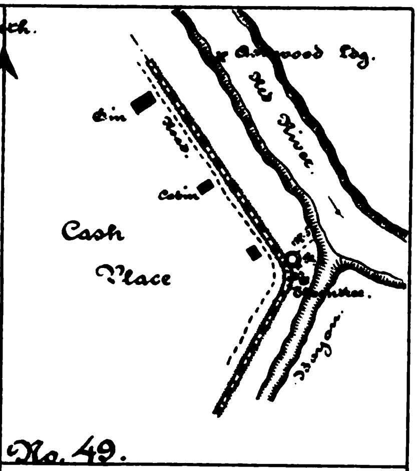

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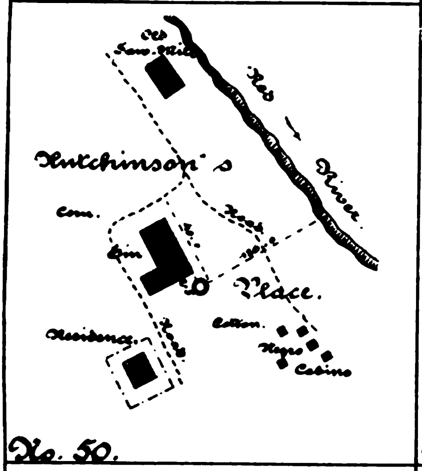

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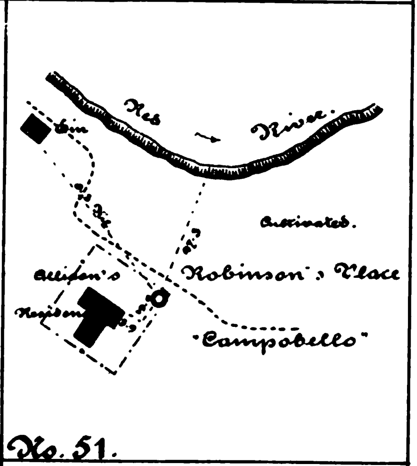

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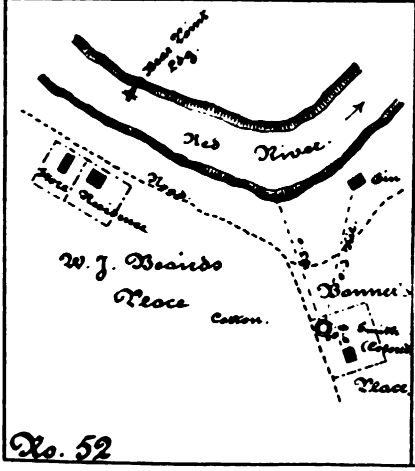

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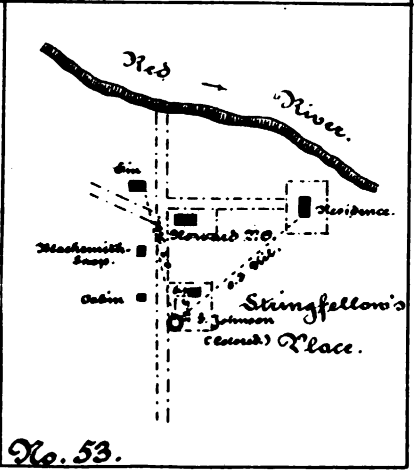

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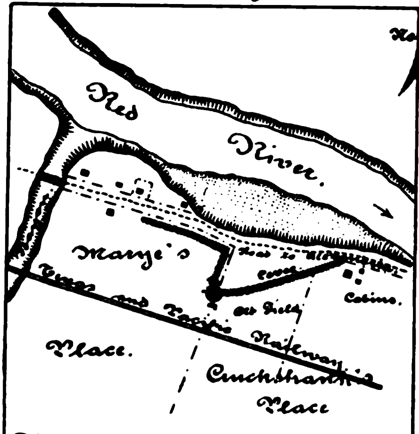

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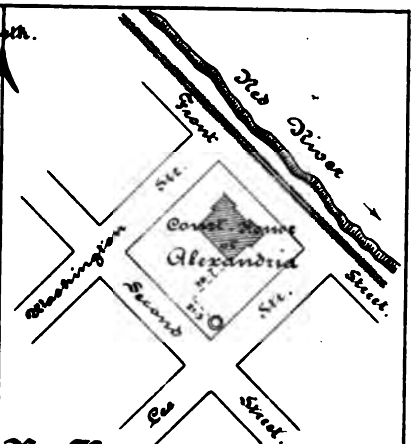

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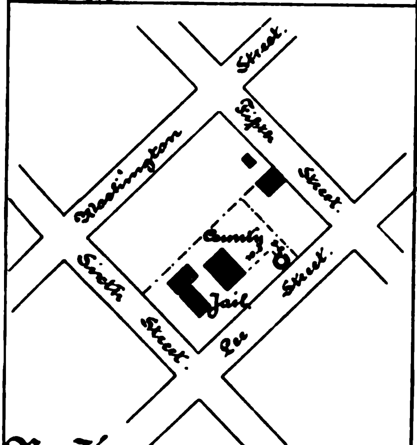

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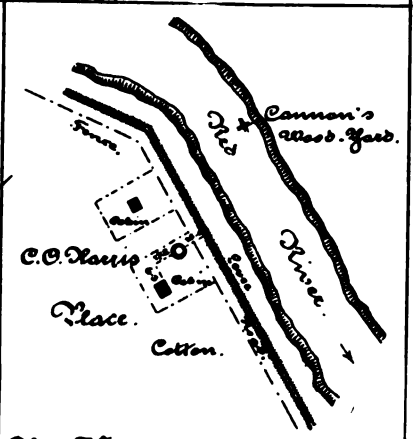

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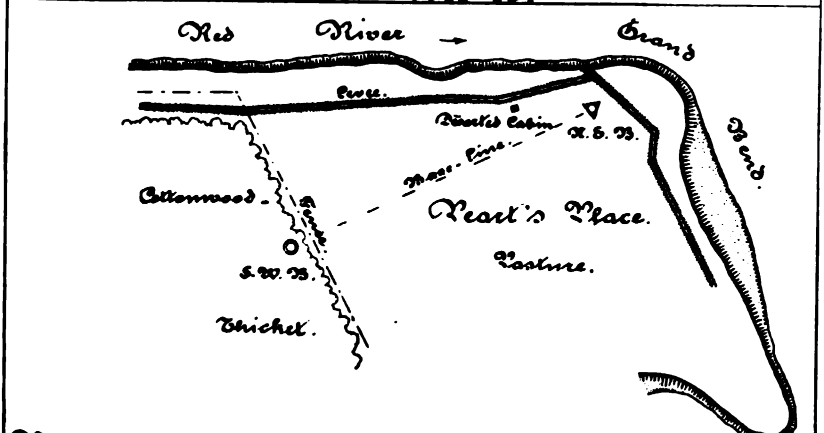

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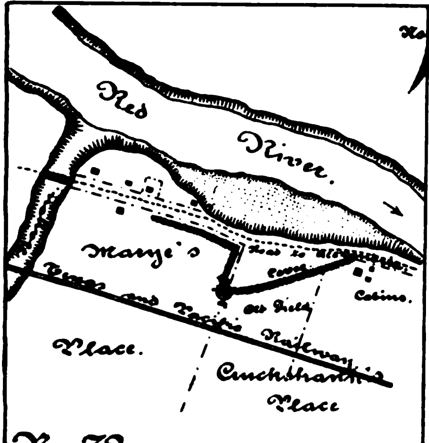

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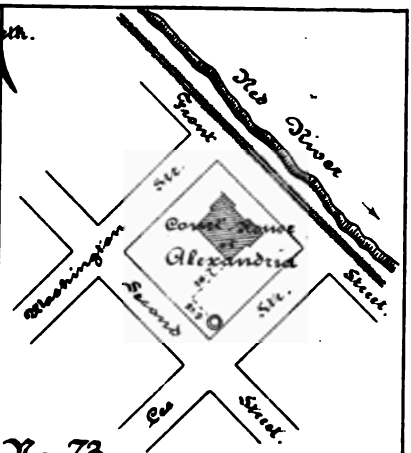

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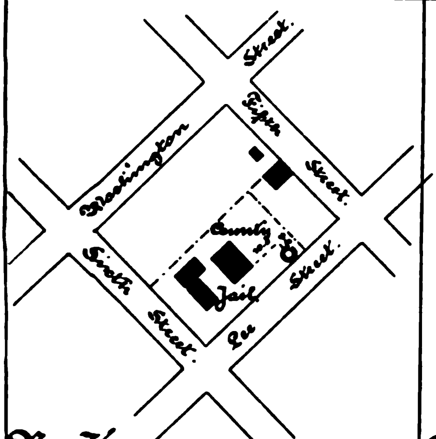

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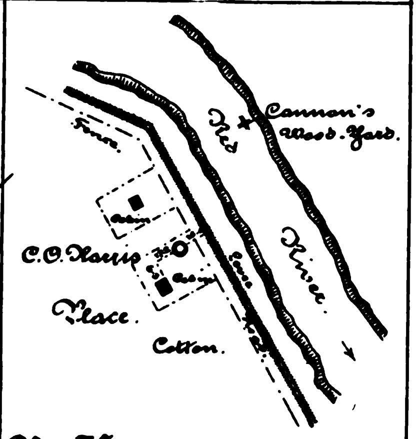

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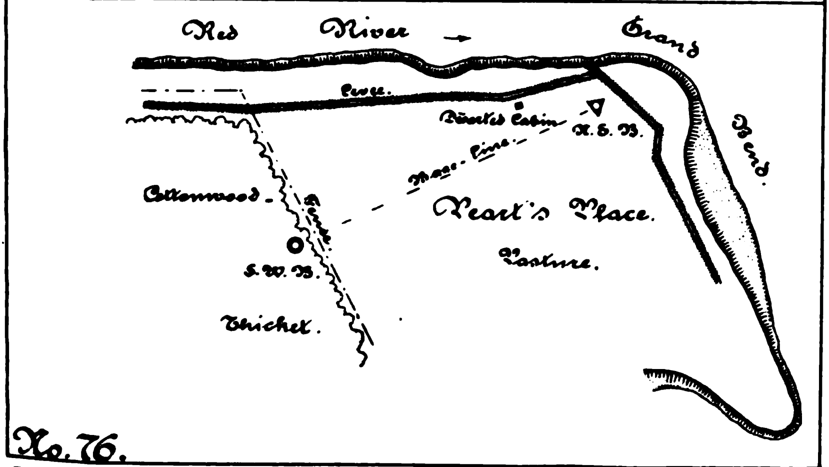

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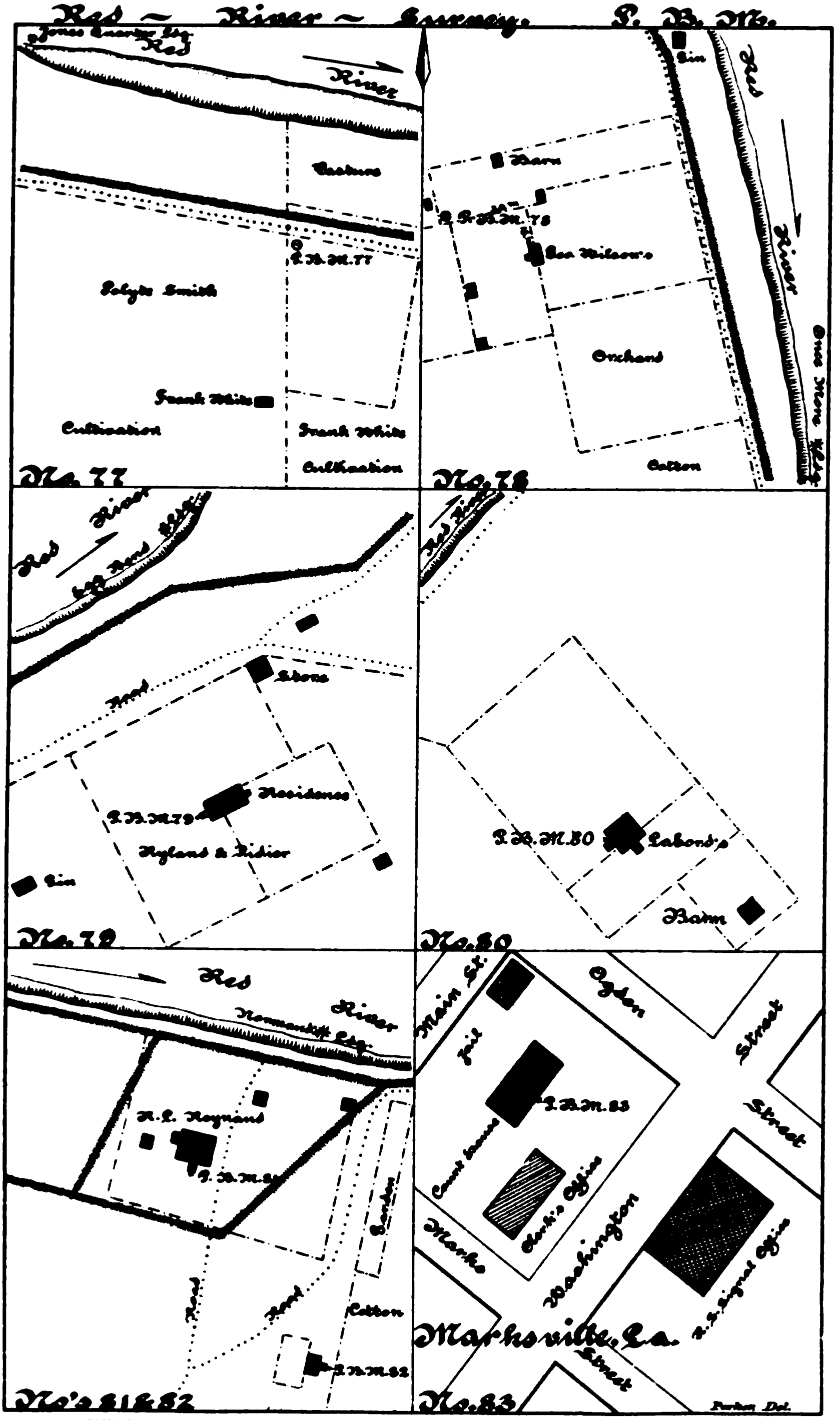

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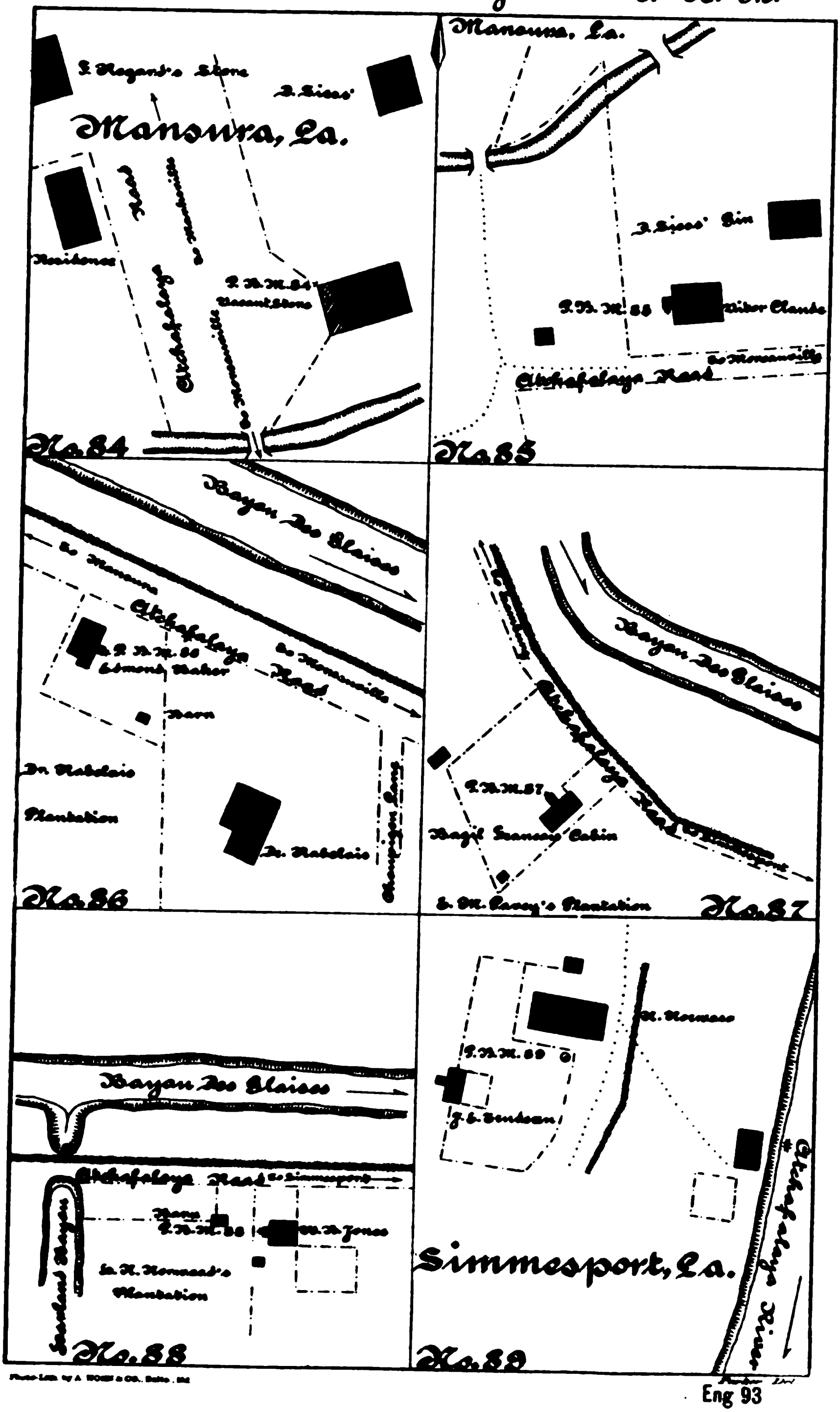
# Red – River – Survey P. B. M.



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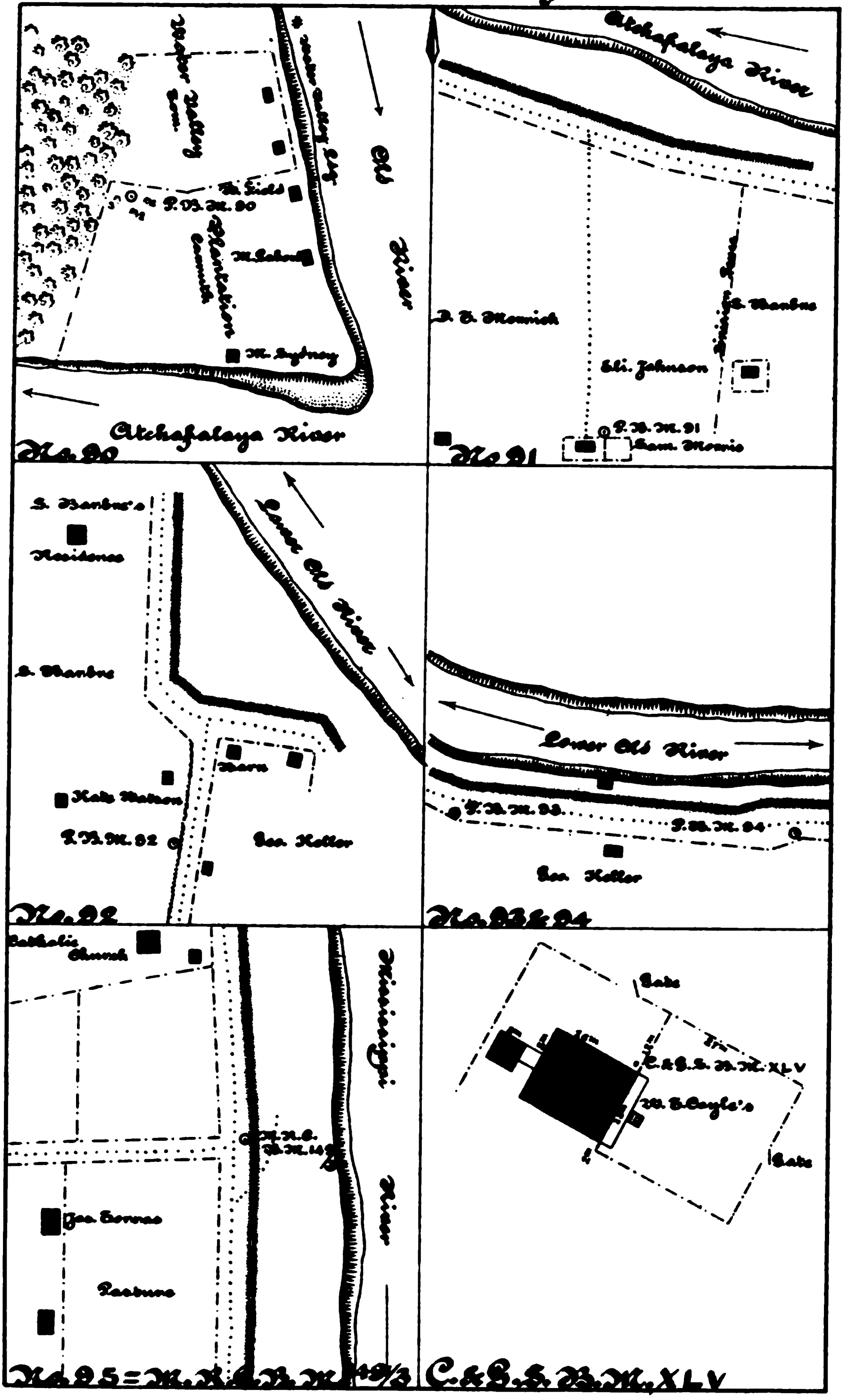
# Red — River — Survey P. B. M.



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State levee, and 81 meters back from bank of Red River. On property of Frank White, 1 meter from division line of Polyte Smith. Elevation, 26.388.

P. B. M. 78: About 3.1 kilometers below Poland post-office, at Once More Landing, Rapides Parish, La. It is situated in lower rear fence corner of George Wilson's horse lot. Elevation, 24.727.

P. B. M. 79: Egg Bend Landing, Avoyelles Parish, La. Top of broken-off wire nail leaded vertically into bottom course of footing of brick chimney at southwest end of dwelling south from Ryland and Didier's store. Elevation, 24.924.

P. B. M. 80: David Ferry, Avoyelles Parish, La. Is horizontal cut in hemispherical head of copper bolt leaded horizontally into 17th course of brick above the footing, near the middle of northwest face of chimney at southwest end of house occupied by
U. S.
—— Laborde. Letters ⊖ are cut into the brick. House is on right bank of
B. M.
Red River, about 400 meters above road to Marksville, La. Elevation, 26.406.

P. B. M. 81: Normands Landing, Avoyelles Parish, La. Is center of horizontal cut in head of copper bolt leaded horizontally into 16th course of brick above footing, near middle of south face of chimney at south end of house occupied by R. L. Reynaud, on right bank of Red River. Letters B. ⊖ M. cut in brick. Elevation, 24.937.

P. B. M. 82: Normands Landing, Avoyelles Parish, La. Is center of horizontal cut in head of copper bolt leaded horizontally into 12th course of brick above footing, near middle of east face of chimney at east side of house occupied by Wm. Vanosdell and owned by R. L. Reynaud. Letters B. M. cut in brick. Elevation,
25.018. ⊖

P. B. M. 83: Marksville, Avoyelles Parish, La. Is horizontal cut in head of copper bolt leaded horizontally into 18th course of brick above ground, about the middle of east (Washingtons street) side of parish court-house. It is between the
U. S.
east door and the window near front side. Marked ⊖ U. S. signal office is east
B. M.
of court-house. Elevation, 32.856.

P. B. M. 84: Mansura, Avoyelles Parish, La. Is horizontal cut in head of copper bolt leaded horizontally in northwest pier of gallery of unoccupied store, owned by David Siess, on east side of road. Store is about 30 meters south southwest of David Siess' dwelling and about 85 meters southeast of F. Regard's store, marked B. ⊖ M. Elevation, 29.475.

P. B. M. 85: Near southern limits of Mansura, Avoyelles Parish, La. Is horizontal cut in head of copper bolt leaded horizontally into 19th course of brick above ground, on south side of chimney at west end of Mme. Victor Claude's dwelling on
U. S.
north side of road leading to Moreauville. Marked ⊖ Elevation, 30.470.
B. M.

P. B. M. 86: Moreauville, Avoyelles Parish, La. Is horizontal cut in head of copper bolt leaded horizontally into 22d course of brick, above ground, of chimney on east side of cabin occupied by Edmond Baker (colored) on Dr. Rabelais' plantation. Cabin is about 50 meters south of right bank of Bayou dés Glaisés and about 1,000 meters west of where Hamburg road leaves the bank of the bayou. Marked
B. M.
⊖ . Elevation, 24.852.

P. B. M. 87: About 445 meters southeast of Hamburg, Avoyelles Parish, La. Is center of copper bolt leaded horizontally into 21st course of brick, above ground, in chimney on west side of cabin occupied by Brazil François on F. M. Pavey's plantation. Cabin is situated about 66 meters from edge of right bank of Bayou dés Glaisés. Marked B. ⊗ M. Elevation, 23.157.

P. B. M. 88: About 2.4 kilometers (measured along road) west of Simmesport, Avoyelles Parish, La. Is center of cross in head of copper bolt leaded horizontally into thirteenth course of brick, above ground, of chimney of cabin occupied by W. B. Jones (colored) on H. N. Norwood's plantation. Cabin is on right bank of Bayou dés Glaisés and on Atchafalaya road about 175 meters east of Harland's (also called Holland's) Bayou. Marked B. ⊗ M. Elevation, 21.578.

P. B. M. 89: Simmesport, Avoyelles Parish, La. Is in northeast corner of J. E. Trudeaus' front yard and just south of N. Norwood's store. Elevation, 18.971.

P. B. M. 90: On Tom Carruth's plantation, near Water Valley Landing, Avoyelles Parish, La. Is 25 meters east of wood line fence, 338 meters west of cabin occupied by William Fields (colored), and 375 meters west of cabin occupied by M. Laborde. Witnessed by three blazed hackberry trees, as follows: First, 1 meter diameter, 66° 30′, 8 meters; second, 0.6 meter diameter, 328° 40′, 23 meters; third, 0.6 meter diameter, 271° 25′, 11 meters. All on right bank of Old River and right bank of the Atchafalaya River. Elevation, 19.194.

P. B. M. 91: Near Merrick post-office, Pointe Coupèe Parish, La. Is at corner of fence around cabin occupied by Sam Morris on D. T. Merrick's plantation, and 285 meters south of levee. Elevation, 19.758.

P. B. M. 92: Near Barbre Landing, Pointe Coupée Parish, La. Is on S. Barbrés plantation on west side of hedge, on west side of lane dividing S. Barbrés and George Keller's plantations. It is about 125 meters south of levee and 99 meters southeast of cabin occupied by Kate Watson (colored) and 273 meters south of S. Barbré's residence. Elevation, 19,839.

P. B. M. 93: About 780 meters (measured along road) southeast of Barbre Landing, Pointe Coupée Parish, La. Is top of copper bolt cemented in top of marble post (15 centimeters by 15 centimeters) about 13 meters from levee in corner of fence. Marked $\boxed{\begin{array}{c}\text{U. S.}\\ \cdot\\ \text{N. O.}\end{array}}$ Elevation, 21.343.

P. B. M. 94: About 1,275 meters (measured along road) southeast of Barbre Landing, Pointe Coupée Parish, La. Is top of copper bolt cemented in top of marble post (15 by 15 centimeters). Is in front of George Heller's plantation at corner of fence and 13 meters from levee. Marked $\boxed{\begin{array}{c}\text{U. S.}\\ \cdot\\ \text{N. O.}\end{array}}$ Elevation, 21.542.

M. R. C. B. M. $\frac{1}{3}{}^{9}$: Near Torras Landing, Pointe Coupée Parish, La. Is center of top of limestone post (15 by 15 centimeters) at angle in levee, at end of lane on north side of Jos. Torras' residence and 165 meters south of Catholic church. Marked $\boxed{\text{U. S.}}$ Elevation, 22.111.

*C. & G. S. B. M. XLV: Smithland, Pointe Coupée Parish, La. Is a granite post placed in yard of W. T. Coyle, at northeast corner of residence. Elevation, 20.983.

### TABLE 4—DESCRIPTIONS AND ELEVATIONS OF BENCH MARKS FROM FULTON, ARK., TO SHREVEPORT, LA.

[E. J. Thomas, leveler.]

NOTE.—Elevations are in meters above Cairo datum, and apply to top of bolt in underground stone. Elevation of boss of pipe-cap can be found in any case by adding 1.24 meters to the tabular elevation.

B. M. 1: On north side of Mount Prairie street, Fulton, Ark., in southeast corner of B. F. Davis's yard, 125 feet from railway (side track) and about 500 feet from large warehouse on river bank. Elevation, 83.52.

B. M. 2: At northeast corner of Washington and Orleans streets, Fulton, Ark., in southeast corner of Gus. Taylor's yard, opposite Heath's Hotel. Elevation, 84.02.

B. M. 3: At northeast corner of house of Gib. Adams, about 1,000 feet back of Adams Landing and 50 feet south of Fish Bayou. Bench is 2 feet from house. (In 1893 this B. M. was found in danger of caving off, and was reset as B. M. 3*a*.) Elevation, 82.03.

B. M. 3*a*: On Brook's plantation, in edge of fringe of timber (field side) on left bank, about 700 feet below plantation quarters. Elevation, 82.91.

B. M. 4: At northeast corner of St. Louis Southwestern Railway section house, at Garland City, Ark. It is 2,020 feet from center pier of railroad bridge, measured along railroad track, and 70 feet north of track. Elevation, 76.53.

B. M. 5: On Cryer's plantation, on top of levee, and at southwest corner of old field, just above negro house, and about 400 feet from river. The bench is just above first point on right bank below Dr. Candler's. Elevation, 74.69.

B. M. 6: On Booker's plantation, 1,000 feet above store at landing. Bench is at bend in levee, 300 feet above frame shanty standing inside the levee. Elevation, 73.00.

B. M. 7: At northeast corner of store at Collins Bluff, 4 feet from north face and 1 foot from east face of building. Elevation, 75.73.

B. M. 8: At southeast corner of Dr. Vance's residence, 1,000 feet above Gilmer Landing and 500 feet from river. Elevation, 73.90.

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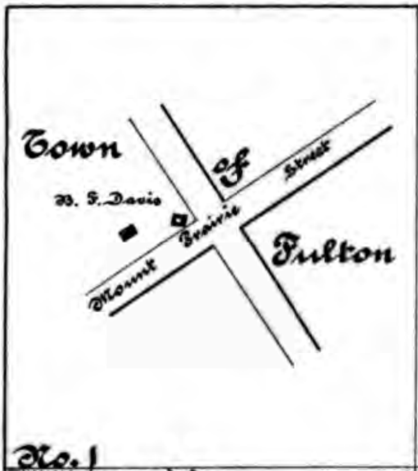
*The elevation of P. B. M. XLV from Mississippi River Commission Report is 20.9832 meters, Cairo datum, and Red River Survey came on to this P. B. M. with the elevation 21.005 meters, Cairo datum, from Delta, La. Since the difference is small, the adjustment is only carried back as far as the Atchafalaya River and is applied as a minus correction of 22 millimeters minus 1 millimeter for each kilometer between P. B. M. XLV and P. B. M. 90.

# Red River Survey B. M.



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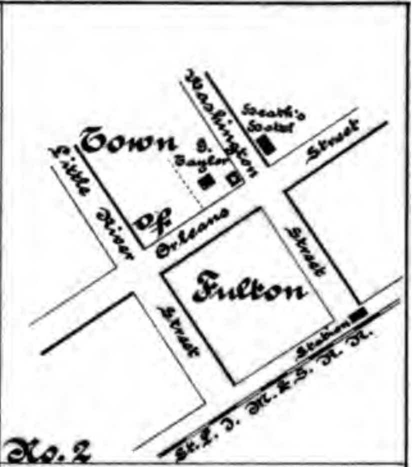

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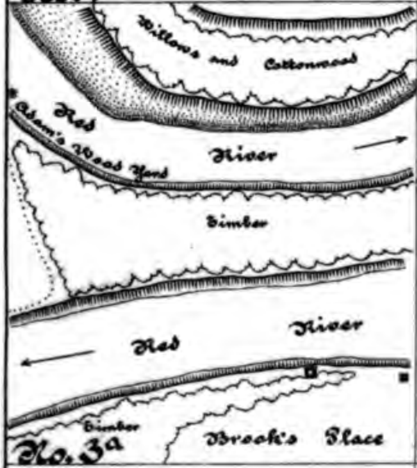

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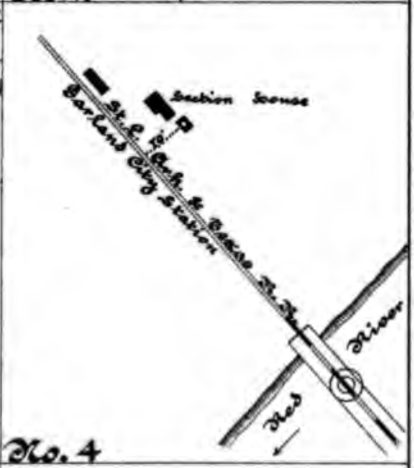

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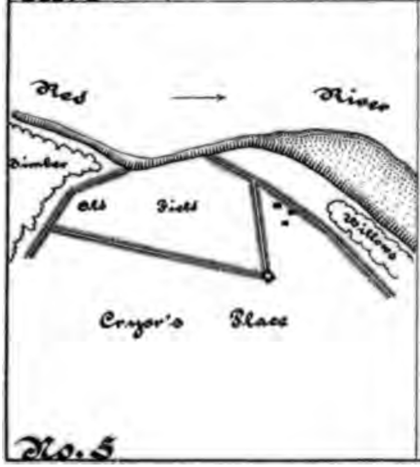

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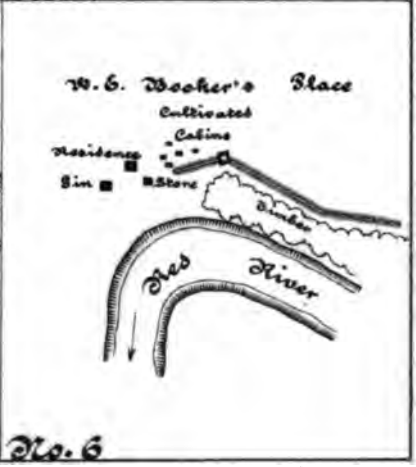

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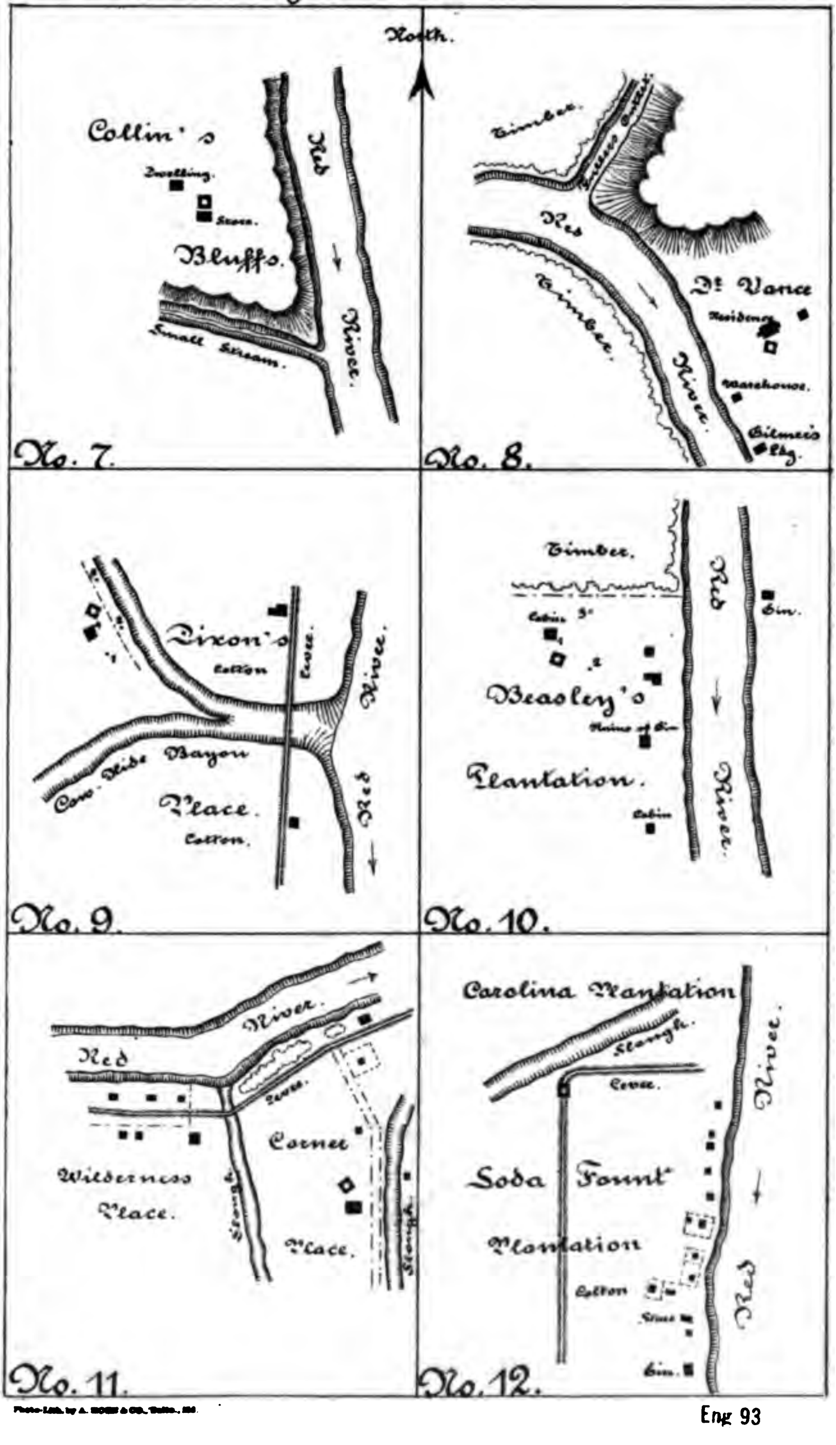

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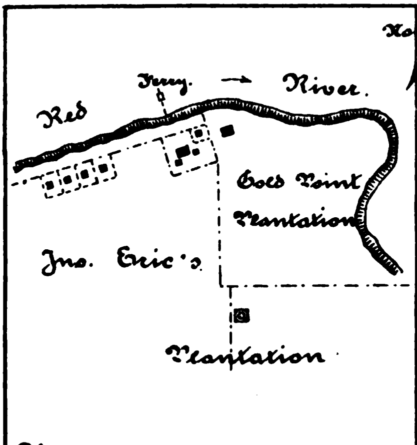
Red River Survey. - B. M. -



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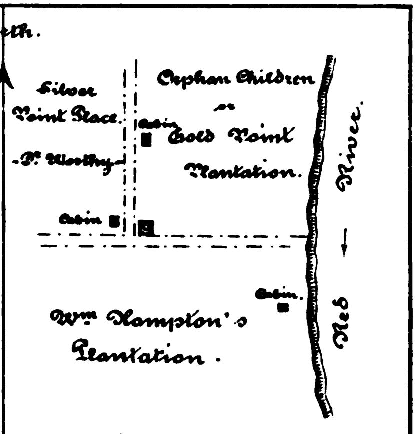

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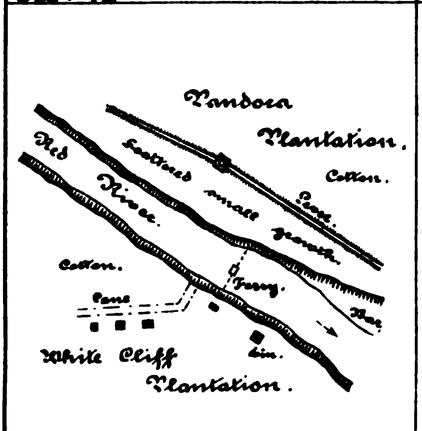

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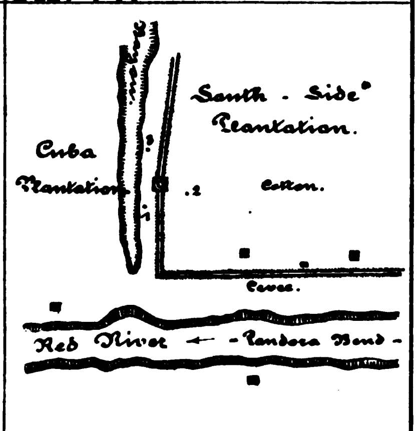

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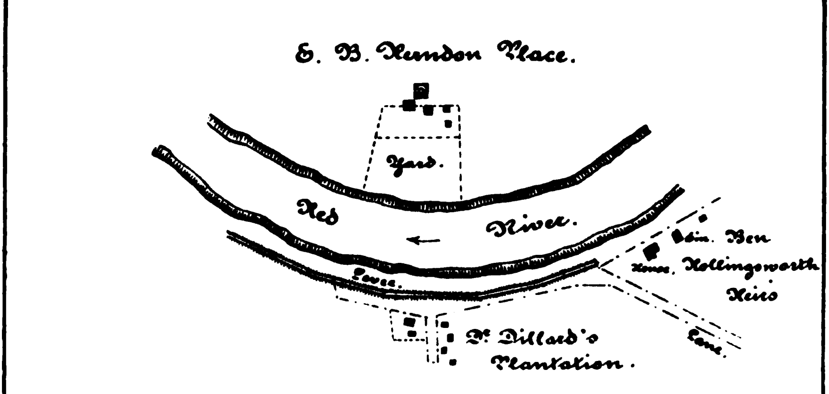

No. 17.

Photo-Lith. by A. Hoen & Co., Baltim. Md

B. M. 9: At northeast corner of cabin in field lying between the two branches of Cow Bayou, about 2,500 feet above Dixon's Store and 400 feet back of levee across mouth of bayou. Elevation, 64.07.

B. M. 10: At southeast corner of cabin, 1,000 feet back of store at Beazleys Landing; 30 feet from fence along edge of the clearing. Elevation, 63.14.

B. M. 11: On Corner plantation, about 2,500 feet below Cottonwood Bayou, at corner of third cabin back from river, along a small slough emptying into the river near steam gin. Elevation, 61.75.

B. M. 12: On back levee of Soda Fount plantation, near corner where levee turns and runs toward river along line between Soda Fount and Carolina plantations. Elevation, 61.21.

B. M. 13: On John Eric's plantation, 800 feet back of gin, standing just below ferry, at corner of field back of and below plantation house. Elevation, 61.24.

B. M. 14: At southwest corner of Gold Point plantation, about 600 feet from river and 150 feet from cabin on Silver Point plantation. Bench is at intersection of lanes running on section lines S. and N. and E. and W., respectively. Elevation, 60.51.

B. M. 15: On Pandora plantation, about 1,000 feet above White Hall or White Cliff Ferry. Bench is on levee at first bend in same above ferry. Elevation, 61.40.

B. M. 16: On Southside plantation, at top of levee running back from river along small bayou, separating Southside and Cuba plantations. Bench is about 800 feet from river. Elevation, 60.04.

B. M. 17: On E. B. Herndon's place, about 2¼ miles above Shreveport, back of cabin standing opposite plantation house of Dr. Dillard, about 600 feet from river. Elevation, 59.39.

### TABLE 5.—DESCRIPTIONS AND ELEVATIONS OF RIVER SECTION REFERENCE POINTS, SHREVEPORT, LA., TO HEAD OF ATCHAFALAYA RIVER, LOUISIANA.

[R. S. Buck, jr., F. B. French, E. T. Washburn, W. H. Polk, L. Y. Kerr, W. W. Olney, and G. C. Haydon, topographers; C. H. Schermerhorn and Fred. McCalla, levelers.]

NOTE.—These reference points are placed in lines normal to river channel at intervals of about 8 kilometers, four reference points in each line. Any reference point is designated by the number of its line, counting from Shreveport, and by its number in the line counting from point No. 1 at outer end of line on right bank to No. 4 at outer end on left bank. Points marked by vitrified pipes set in ground and filled with cement. Elevations are in meters above Cairo datum.

#### *Stone line No. 1.—Fullilove's Chalk Level plantation.*

**Stone** $\frac{1}{1}$: Is on Grigsby Island, right bank of Old River, 350 meters above where levee crosses island. Elevation, 58.27.

Stone $\frac{1}{2}$: Is same as △ 12 on Grigsby Island, right bank of Red River, just inside of levee, 50 meters east of cabin and 100 meters above where levee crosses island. Elevation, 59.02.

Stone $\frac{1}{3}$: Is on Fullilove's Chalk Level plantation, just on edge of left bank, 150 meters above point of bend at lower plantation line. Elevation, 58.60.

Stone $\frac{1}{4}$: Is on Fullilove's plantation, 250 meters above lower plantation line and 150 meters northwest of plantation overseer's house in bend of river. Elevation, 58.24.

#### *Stone line No. 2.—One thousand meters above Eagle Bend.*

Stone $\frac{2}{1}$: On Crowder's Eagle Bend plantation, in edge of timber, 150 meters above where it turns south back of plantation residence. Elevation, 54.59.

Stone $\frac{2}{2}$: On Crowder's Eagle Bend plantation, 75 meters from right bank and just inside of levee, 1,000 meters above Eagle Bend. Elevation, 56.76.

Stone $\frac{2}{3}$: Is on the lower Fullilove plantation, 100 meters above the plantation overseer's house, just inside of levee. Elevation, 57.09.

Stone $\frac{2}{4}$: Is on the lower Fullilove plantation, 600 meters north of plantation overseer's house, almost in the middle of the field. Elevation, 56.00.

#### *Stone line No. 3.*

Stone $\frac{3}{1}$: Is in the yard 50 meters back of residence on the Caldwell plantation, just below Lattier Cut-off. Elevation, 56.18.

Stone $\frac{3}{2}$: Is 50 meters from right bank, just inside of levee on the Caldwell plantation, 350 meters south of residence. Elevation, 56.34.

Stone $\frac{3}{3}$: Is on Pruitt's plantation, 50 meters above division line between Pruitt and Sunny Point plantations. On the inside at foot of levee. △ 30 is on top. Elevation 56.03.

Stone $\frac{3}{4}$: Is same as $\frac{4}{4}$. In edge of timber 375 meters below division line between Sunny Point and Pruitt plantations, on Sunny Point plantation. Elevation, 55.68.

### *Stone line No. 4.—One and one-half miles above Scopini Cutoff.*

Stone $\frac{4}{1}$: Is same as △ 32. On Judge George's plantation, 150 meters southeast of cabin and 150 meters from right bank. Elevation 55.34.

Stone $\frac{4}{2}$: Is on top of levee 50 meters from right bank and 100 meters east of cabin, 1½ miles above Scopini Cut-off. Elevation, 56.54.

Stone $\frac{4}{3}$: Is on top of levee 50 meters from left bank on Sunny Point plantation, 1½ miles above Scopini Cut-off. Elevation, 57.10.

Stone $\frac{4}{4}$: Is same as $\frac{3}{4}$. In edge of timber, 375 meters below division line between Sunny Point and Pruitt plantations, on Sunny Point plantation. Elevation, 55.68.

### *Stone line No. 5.—One mile above Lotus Landing.*

Stone $\frac{5}{1}$: On top of levee on Maryland plantation, right bank of Old River, 300 meters above division line between Maryland and Capt. Robson's plantations. Elevation, 55.46.

Stone $\frac{5}{2}$: Is same as △ 38. On Maryland plantation, 75 meters from right bank and 450 meters above division line between Maryland and Capt. Robson's plantation. Elevation, 55.04.

Stone $\frac{5}{3}$: Is on the Mercer plantation, at inside foot of levee, 50 meters from left bank, at corner of cabin yard, 350 meters below division line between Mercer and Lattier plantations. Elevation, 55.52.

Stone $\frac{5}{4}$: Is 450 meters east of $\frac{5}{3}$ on Mercer plantation. Elevation, 53.60.

### *Stone line No. 6.—One-half mile below Waterloo Cutoff.*

Stone $\frac{6}{1}$: Is in the edge of timber, 300 meters a little southwest of residence on the Brown-Jacobs plantation. Elevation, 53.17.

Stone $\frac{6}{2}$: On top of levee, 100 meters northwest of residence on the Brown-Jacobs plantation. Elevation, 54.56.

Stone $\frac{6}{3}$: Is at foot of levee, on land side, on the lower Mercer plantation, 110 meters above lane forming the division line between the Mercer and Pickett plantations. Elevation, 54.33.

Stone $\frac{6}{4}$: Is on the lower Mercer plantation, 100 meters northwest of negro church and 65 meters from lane dividing the Mercer and Pickett plantations. Elevation, 53.38.

### *Stone line No. 7.—Young Point.*

Stone $\frac{7}{1}$: Is on Pat. Cash's plantation, 125 meters east of Kelly Bayou and 300 meters northwest of junction of Pascagoula and Kelly Bayou and Prairie River. Elevation, 52.61.

Stone $\frac{7}{2}$: Is on Pat. Cash's plantation, just inside and at angle of levee, 130 meters due west of head of Pascagoula Bayou. Elevation, 53.23.

Stone $\frac{7}{3}$: Is 50 meters from left bank, at lower end of Old River Bend, on Young Point plantation. Elevation, 54.01.

Stone $\frac{7}{4}$: Is on Young Point plantation, 375 meters back from middle of Old River Bend; is 260 meters from upper and 370 meters from lower arm of Old River. Elevation, 53.13.

### *Stone line No. 8.—Two hundred and nineteen and one-half miles below Fulton, Ark.*

Stone $\frac{8}{1}$: Is in the middle of the lower right-hand point of Pascagoula plantation. Is surrounded by several large elm trees in the head of small marsh. Elevation, 53.10.

Stone $\frac{8}{2}$: Is in the lower right-hand point of Pascagoula plantation, near middle of the bend of river, 50 meters from right bank in edge of skirt of timber. Elevation, 53.89.

Stone $\frac{8}{3}$: Is at corner of cabin, on road, 125 meters north of residence, on Bates plantation. Elevation, 52.95.

Stone $\frac{8}{4}$: Is on Bates plantation, 200 meters a little northeast of residence and 90 meters north of fence running from barn to timber. Elevation, 51.62.

### *Stone line No. 9.—One and one-half miles above Knox Point.*

Stone $\frac{9}{1}$: Is on upper part of Magnolia plantation, 525 meters from river and 250 meters south of lane dividing Magnolia and the Nesbitt plantations. Elevation, 52.06.

Stone $\frac{9}{2}$: Is on Nesbitt plantation, 25 meters from right bank, and is 150 meters along river bank from mouth of lane dividing Nesbitt and Magnolia plantations. Elevation, 53.02.

Stone $\frac{9}{3}$: Is 1¼ miles above Knox Point, on the Knox Point plantation. Is 75 meters from left bank, at beginning of bend in edge of skirt of timber. Elevation, 53.08.

Stone $\frac{9}{4}$: Is in the middle of upper left hand point of Knox Point plantation, 350 meters from river. Elevation, 52.85.

### *Stone line No. 10.—Caspiana Landing.*

Stone $\frac{10}{1}$: On left bank of drain, 25 meters north of mouth of lane dividing Magnolia and Caspiana plantations. Elevation, 51.59.

Stone $\frac{10}{2}$: Is in the lane dividing Magnolia and Caspiana Plantations. Is near the upper fence line 75 meters from right bank. Elevation, 52.15.

Stone $\frac{10}{3}$: Is on Lovely Point plantation, 50 meters from left bank and 250 meters nearly west of the last cabin in the point. Elevation, 52.42.

Stone $\frac{10}{4}$: Is on Lovely Point plantation, 25 meters from left bank of river and 75 meters along river bank from the last cabin in the point. Elevation, 53.06.

### *Stone line No. 11.—One-eighth mile below the church on Campobello plantation.*

Stone $\frac{11}{1}$: Is on Campobello plantation, 50 meters from ditch and 200 meters south of fence running east and west below the church on Campobello plantation. Elevation, 51.28.

Stone $\frac{11}{2}$: Is on Campobello plantation, just inside of fence along roadside 200 meters below the church. Elevation, 53.03.

Stone $\frac{11}{3}$: Is on Christiana plantation, 50 meters from left bank, 125 meters south of cabin nearly opposite the church on Campobello plantation. Elevation, 52.38.

Stone $\frac{11}{4}$: Is on Christiana plantation, 150 meters north of an inclosed cabin on left bank. Elevation, 51.57.

### *Stone line No. 12.—Cross Keys plantation.*

Stone $\frac{12}{1}$: Is on Cross Keys plantation, 50 meters west of drain and 100 meters south of cabin on lane running west from the residence. Elevation, 50.66.

Stone $\frac{12}{2}$: Is on Cross Keys plantation, 50 meters from right bank and 100 meters south of residence. Elevation, 51.65.

Stone $\frac{12}{3}$: Is on Bear Point plantation, 50 meters from left bank, in edge of skirt of timber 50 meters north of cabin. Elevation, 52.15.

Stone $\frac{12}{4}$: Is on Bear Point plantation, 100 meters west of slough running into Ninock Lake, and 400 meters from river. Elevation, 51.23.

### *Stone line No. 13.—Mouth of Ninock Bayou, Cotton Point plantation.*

Stone $\frac{13}{1}$: Is in the middle of neck on Cotton Point plantation opposite mouth of Ninock Bayou; is 400 meters from the river at middle of bend and 30 meters north of ditch. Elevation, 50.81.

Stone $\frac{13}{2}$: Is on Cotton Point plantation at the middle of the bend opposite Ninock Bayou; is 50 meters from right bank and 25 meters on the outside from levee. Elevation, 51.94.

Stone $\frac{13}{3}$: Is on the Ninock plantation, 100 meters from left bank and 200 meters south of the mouth of Ninock Bayou. Elevation, 51.42.

Stone $\frac{13}{4}$: Is on the upper part of the Ninock plantation, 25 meters from left bank of small drain and 100 meters south of cabin. Elevation, 51.36.

### *Stone line No. 14.—Two hundred and forty-seven miles from Fulton, Ark.*

Stone $\frac{14}{1}$: Is in the middle of the lower right-hand neck of Cotton Point plantation, 400 meters from river at middle of bend; is on line with and equidistant from two cabins on the left bank, one above and one below point. Elevation, 50.81.

Stone $\frac{14}{2}$: Is at the beginning of bend, 25 meters from right bank, at lower right-hand neck of Cotton Point plantation. Elevation, 51.57.

Stone $\frac{14}{3}$: Is on Desarc plantation, 75 meters from left bank at point of bend 300 meters south of residence. Elevation, 50.35.

Stone $\frac{14}{4}$: Is on Desarc plantation, 400 meters from river; 425 meters northeast of church, and 250 meters north of cabin near the south line of plantation. Elevation, 49.18.

### *Stone line No. 15.—One and one-half miles above Loggy Bayou.*

Stone $\frac{15}{1}$: Is on Mound Flat plantation, 50 meters south of point of timber and 200 meters northwest of cabin that is 350 meters along road from mouth of lane at lower plantation line. Elevation, 49.95.

Stone $\frac{15}{2}$: Is on Mound Flat plantation, 50 meters from right bank in edge of skirt of timber and is 40 meters northeast of cabin that is 350 meters along road from mouth of lane at lower plantation line. Elevation, 51.11.

Stone $\frac{15}{3}$: Is on Treadwell plantation, 75 meters from left bank and 30 meters south of cabin that is 325 meters south of upper plantation line. Elevation, 50.75.

Stone $\frac{15}{4}$: Is on Treadwell plantation, 25 meters from ditch, 175 meters below the upper angle. The ditch is 50 meters from Loggy Bayou. Elevation, 49.99.

### *Stone line No. 16.—East Point, La.*

Stone $\frac{16}{1}$: Is on Williams plantation, 350 meters from river opposite East Point. Elevation, 50.01.

Stone $\frac{16}{2}$: Is on Williams plantation, 75 meters from right bank and 50 meters west of cabin. Opposite East Point. Elevation, 50.21.

Stone $\frac{16}{3}$: Is at East Point, 75 meters back from river west of store in lot owned by W. P. Scarborough. Elevation, 50.25.

Stone $\frac{16}{4}$: Is at East Point, 100 meters west of the church in the northeast corner of vacant lot owned by ——— Williams. Elevation, 49.96.

### *Stone line No. 17.—One-half mile below Star Point Behd.*

Stone $\frac{17}{1}$: Is on Ashland plantation, 100 meters southeast of cabin and 200 meters north of gin. Elevation, 48.57.

Stone $\frac{17}{2}$: Is on Ashland plantation, 75 meters from cabin near fence running northwest from residence. Elevation, 49.31.

Stone $\frac{17}{3}$: Is on Star Point plantation, 60 meters from left bank and 150 meters east of cabin. Elevation, 49.71.

Stone $\frac{17}{4}$: Is on Star Point plantation, 175 meters southeast of residence and 150 meters west of cabin. Elevation, 49.36.

### *Stone line No. 18.—One-half mile above mouth of Grand Bayou.*

Stone $\frac{18}{1}$: Is on Murrell's plantation, 175 meters from right bank in the woods; is 25 meters from bank of east prong of pocket and 75 meters east from main bank. Elevation, 46.53.

Stone $\frac{18}{2}$: Is on Murrell's plantation in edge of woods, 50 meters from right bank and 25 meters above main bank of pocket. Elevation, 47.60.

Stone $\frac{18}{3}$: Is on Willow Grove plantation, one-half mile above the mouth of Grand Bayou opposite mouth of pocket, 50 meters from left bank in the woods. Elevation, 50.06.

Stone $\frac{18}{4}$: Is on Willow Grove plantation in the middle of the wooded point opposite mouth of Grand Bayou. Elevation, 48.30.

### *Stone line No. 19.—Two hundred and sixty-eight and three-fourth miles below Fulton, Ark.*

Stone $\frac{19}{1}$: Is on Greening plantation, 350 meters from right bank and 300 meters from cabin that is 150 meters above lower junction of main and second bank. Elevation, 47.91.

Stone $\frac{19}{2}$: Is on Greening plantation, 100 meters from right bank and 25 meters back of cabin that is 150 meters above lower junction of main and second bank. Elevation, 49.20.

Stone $\frac{19}{3}$: Is on Greening plantation, 75 meters from left bank and 200 meters in front of cabin. Elevation, 47.46.

Stone $\frac{19}{4}$: Is near fence line in edge of timber on Greening plantation, left bank, and is 125 meters northeast of cabin. Elevation, 47.00.

### *Stone line No. 20.—Two hundred and seventy-three and eight-tenths miles below Fulton, Ark.*

Stone $\frac{20}{1}$: Is on Britt Lee's plantation, 50 meters west of south point of strip of timber and 150 meters from upper plantation line. Elevation, 47.65.

Stone $\frac{20}{2}$: Is on Britt Lee's plantation, 100 meters from right bank and 125 meters south of double cabins on lane forming division line between Britt Lee's and Bonnie Doon plantations. Elevation, 48.78.

Stone $\frac{20}{3}$: Is on Carroll plantation, 75 meters from left bank and 225 meters south of residence. Elevation, 49.13.

Stone $\frac{20}{4}$: Is on Carroll plantation, 475 meters from river and 225 meters south of lane running back from residence. Elevation, 47.35.

### *Stone line No. 21.—One-fourth mile below Coushatta, La.*

Stone $\frac{21}{1}$: Is on Cabin Point plantation, 375 meters from river and 150 meters from cabin that is 350 meters west of gin. Elevation, 47.10.

Stone $\frac{21}{2}$: Is on Cabin Point plantation, 50 meters from right bank and 250 meters below gin. Elevation, 47.48.

Stone $\frac{21}{3}$: Is on Wilson place, 75 meters from left bank 450 meters below Coushatta. Elevation 48.35.

Stone $\frac{21}{4}$: Is on Wilson place, 50 meters from left bank and 75 meters above the first cabin around the bend below Coushatta. Elevation, 48.26.

### *Stone line No. 22.—Six and one-fourth miles below Coushatta, La.*

Stone $\frac{22}{1}$: Is on lower part of Robert H. Brown's plantation near the division fence between Robert H Brown and Tuscan plantations; 100 meters north of long lane running east and west. Elevation, 46.09.

Stone $\frac{22}{2}$: Is on Tuscan plantation, 50 meters from right bank, 100 meters southeast of cabin in the extreme northwest corner of plantation. Elevation, 47.01.

Stone $\frac{22}{3}$: Is on Giddens plantation, 50 meters from left bank and 175 meters southeast of cabin. Elevation, 46.44.

Stone $\frac{22}{4}$: Is on Giddens plantation, 350 meters from river, 75 meters northeast of east point of timber. Elevation, 46.21.

### *Stone line No. 23.—Two-hundred and ninety-one miles below Fulton, Ark.*

Stone $\frac{23}{1}$: Is on Jacob Porter's plantation, 100 meters southwest of cabin that is 250 meters west of residence. Elevation, 45.85.

Stone $\frac{23}{2}$: Is on Jacob Porter's plantation, 75 meters from right bank at outer fence corner in front of cabin 125 meters north of residence. Elevation, 47.42.

Stone $\frac{23}{3}$: Is on Shortway plantation, 50 meters from left bank and 40 meters west of clump of trees at head of washout one-half mile above Old River. Elevation, 44.92.

Stone $\frac{23}{4}$: Is on Shortway plantation, on a back protection levee along a slough of Bayou Nicholas; is 40 meters below angle of levee where it turns toward river. Elevation, 46.14.

### *Stone line No. 24.—One mile above Scopini Bluffs.*

Stone $\frac{24}{1}$: Is on Thorn plantation, 375 meters back of gin and 350 meters north of junction of road and lane. Elevation, 45.72.

Stone $\frac{24}{2}$: Is in the yard southwest of residence on Thorn plantation. Elevation, 46.44.

Stone $\frac{24}{3}$: Is on Lac des Mûres plantation, 50 meters from left bank, 100 meters below a double washout and 250 meters above where main bank leaves river. Elevation, 45.08.

Stone $\frac{24}{4}$: Is on Lac des Mûres plantation, 140 meters northwest of cabin at mouth of drain. Elevation, 45.62.

### *Stone line No. 25.—Three and one-eighth miles below Walnut Hills.*

Stone $\frac{25}{1}$: Is 550 meters southeast of plantation quarters on Lower Brazil plantation; is 550 meters from river on a farm road 325 meters south of a cabin at junction of roads. Elevation, 44.04.

Stone $\frac{25}{2}$: Is on Lower Brazil plantation, 50 meters from right bank and 100 meters north of two cabins facing each other on road running east and west below plantation quarters. Elevation, 45.07.

Stone $\frac{25}{3}$: Is on Poule d'eau Lake plantation, on second bank near fence line 50 meters below the corner of fence running from barn to river. Elevation, 43.08.

Stone $\frac{25}{4}$: Is on Poule d'eau Lake plantation, 225 meters from main bank and 100 meters south of where drain enters at point of woods. △ 161 is 25 meters west. Elevation, 44.38.

### *Stone line No. 26.—Three miles above Campti, La.*

Stone $\frac{26}{1}$: Is on the upper part of Gabriel Prudhomme's plantation on right bank, 50 meters south of junction of roads just east of point of timber. Elevation, 43.86.

Stone $\frac{26}{2}$: Is on the northeast point of Poria's Plantation, 40 meters from right bank and 275 meters above cabin in the extreme point of plantation. Elevation, 43.90.

Stone $\frac{26}{3}$: Is on Gabriel Prudhomme's plantation, on second bank open bar 50 meters from left top bank, 275 meters southeast of mouth of drain at main bank. Elevation, 41.44.

Stone $\frac{26}{4}$: Is on Gabriel Prudhomme's plantation, 500 meters from left top bank, 50 meters south of drain, and 125 meters west of junction of drains. Elevation, 42.42.

### *Stone line No. 27.—One-quarter mile above mouth Bayou Pierre.*

Stone $\frac{27}{1}$: Is on Henry Hyman's plantation, 75 meters from main bank and 75 meters south of residence. Elevation, 43.76.

Stone $\frac{27}{2}$: Is on Henry Hyman's plantation, 50 meters from edge of willows in clearing on second bank and 250 meters northeast of residence. Elevation, 37.69.

Stone $\frac{27}{3}$: Is on Gaiennie Point plantation, 50 meters from left bank and 150 meters above cabin at head of Old River. Elevation, 43.23.

Stone $\frac{27}{4}$: Is on Gaiennie Point plantation, 50 meters from bank of Old River and 40 meters south of cabin. Elevation, 44.01.

### *Stone line No. 28.—Head of Cane River.*

Stone $\frac{28}{1}$: Is on Joseph Perot's plantation, 35 meters from main bank at mouth of lane, 550 meters from river in the cottonwood woods on the second bank. Elevation, 38.59.

Stone $\frac{28}{2}$: Is on Joseph Perot's plantation, 75 meters from river and 50 meters from main bank, 50 meters above a cabin in the point where main bank joins at the river. Elevation, 39.57.

Stone $\frac{28}{3}$: Is on Alex. Semprac's plantation on the outside near the corner of a lot fence, 25 meters north of a cabin on the inside of fence west of gin. Elevation, 43.31.

Stone $\frac{28}{4}$: Is on E. V. Déblieux's plantation, 50 meters from lane, 325 meters northeast of church. Elevation, 40.97.

### *Stone line No. 29.—Tiger Island.*

Stone $\frac{29}{1}$: Is on O'Neal Gibbs' plantation, 60 meters from division line between Gibbs and Lastage plantations, 150 meters from the east side of a pasture back of residence. Elevation, 41.72.

Stone $\frac{29}{2}$: Is on Lastage plantation, 50 meters from river near back fence of lot, 75 meters north of barn. Elevation, 42.11.

Stone $\frac{29}{3}$: Is on L. K. McLaurin's plantation, 50 meters from left bank near southwest corner of lot around house at mouth of lane between L. K. McLaurin's and More's plantations. Elevation, 42.06.

Stone $\frac{29}{4}$: Is on L. K. McLaurin's plantation, 75 meters from right bank of False River, and 40 meters from lane between McLaurin's and More's plantations. Elevation, 41.02.

### *Stone line No. 30.—Three miles above St. Maurice.*

Stone $\frac{30}{1}$: Is on Joseph Cammack's plantation, 25 meters from the left bank of a small bayou 350 meters northwest of a church on road at lower part of plantation. Elevation, 37.08.

Stone $\frac{30}{2}$: Is on Joseph Cammack's plantation, 30 meters from road along river bank, 150 meters above where the road forks, one down the river bank and the other across country by church. Elevation, 40.23.

Stone $\frac{30}{3}$: Is on Hecla plantation, 75 meters from left bank at the beginning of a large sand bar where main bank turns square to the east. Elevation, 39.48.

Stone $\frac{30}{4}$: Is on Hecla plantation, 40 meters from fence, along the edge of woods, and 75 meters southeast of cabin. Elevation, 38.76.

### *Stone line No 31.—One mile below St. Maurice.*

Stone $\frac{31}{1}$: Is on Mrs. A. A. Prothro's plantation, 1 mile below St. Maurice, 175 meters from right bank and 100 meters southwest of cabin at point of timber. Elevation, 39.12.

Stone $\frac{31}{2}$: Is on Mrs. A. A. Prothro's plantation, 1 mile below St. Maurice, 40 meters from right bank and 50 meters from cabin at point of timber. Elevation, 39.87.

Stone $\frac{31}{3}$: Is on New York Lumber Company's plantation, 1 mile below St. Maurice, 50 meters from left bank and 300 meters above head of Old River. Elevation, 39.54.

Stone $\frac{31}{4}$: Is on New York Lumber Company's plantation, 1 mile below St. Maurice, 50 meters north from bank of Old River, at junction of main and second bank, at point of woods extending back from Red River. Elevation, 39.68.

### *Stone line No. 32.—Five miles below St. Maurice.*

Stone $\frac{32}{1}$: Is on Mrs. Sophie Favron's plantation, in lower edge of woods on the point at northeast corner of plantation, 50 meters northeast of fence corner, 200 meters from river and 200 meters north of cabin. Elevation, 38.67.

Stone $\frac{32}{2}$: Is on Mrs. Sophie Favron's plantation on the right bank at edge of woods, 175 meters below the sharp bend in bank. Elevation, 38.82.

Stone $\frac{32}{3}$: Is on C. C. Dunn's plantation, 50 meters from left bank on road, 75 meters from where it leaves river, 200 meters above cabin on the lower plantation line. Elevation, 37.88.

Stone $\frac{32}{4}$: Is on the side of hills on C. C. Dunn's plantation, 100 meters southeast of cabin and 450 meters along the bluffs above residence. Elevation, 45.55.

### *Stone line No. 33.—One-half mile above Montgomery.*

Stone $\frac{33}{1}$: Is on Sam Bernstein's plantation, opposite Montgomery, 50 meters south of a fence running east and west across plantation, 125 meters north of Bayou des Glaises, and is 250 meters east of the junction with the fence running from river south. Elevation, 36.73

Stone $\frac{33}{2}$: Is on Sam Bernstein's plantation, ½ mile above Montgomery, 50 meters from right bank and 50 meters west of a cabin in a small pasture lot. Elevation, 37.62.

Stone $\frac{33}{3}$: Is on R. H. William's plantation, 50 meters from left bank near the fence dividing William's and Christie's plantations. Elevation, 37.11.

Stone $\frac{33}{4}$: Is on R. H. William's plantation, 350 meters from river and 50 meters from fence dividing William's and Christie's plantations. Elevation, 36.10.

### *Stone line No. 34.—One mile below Durand Landing.*

Stone $\frac{34}{1}$: Is on Mrs. M. E. Cofer's plantation, on the right bank of Platte or Flat River, 225 meters above where it enters woods. Elevation, 35.46.

Stone $\frac{34}{2}$: Is on Mrs. M. E. Cofer's plantation, 50 meters from right bank and 150 meters east of cabin. Elevation, 34.95.

Stone $\frac{34}{3}$: Is on T. W. Kimbrell's plantation, in the southeast corner on a spur of the hills, 75 meters from the left bank and 25 meters from the division fence between Kimbrell's and Young's plantations. Elevation, 45.77.

Stone $\frac{34}{4}$: Is on John Young's plantation, upon top of the hills in the pine woods, 200 meters due north from corner of fence of division line between Kimrbell's and Young's plantations. Corner of fence is 200 meters from river. Elevation, 49.54.

### *Stone line No. 35.—One mile below mouth of Little River.*

Stone $\frac{35}{1}$: Is on J. Delouche's plantation, on the north bank of Eagle Nest Bayou, where fence crosses bayou 50 meters south of cabin in edge of woods. Elevation, 34.76.

Stone $\frac{35}{2}$: Is on J. Delouche's plantation, 50 meters from right bank in the edge of woods, 100 meters below cabin on the outside of field. Elevation, 33.26.

Stone $\frac{35}{3}$: Is on J. Bille's plantation, 50 meters from left bank in edge of cottonwoods, 125 meters from the division line between Bille's and Grandchamp plantations. Elevation, 34.00.

Stone $\frac{35}{4}$: Is on J. Bille's plantation, at foot of hills, 225 meters below the division line between Bille's and Grandchamp plantations. Elevation, 36.38.

*Stone line No. 36.—One mile below St. André Bluffs.*

Stone $\frac{36}{1}$: Is on Pierre Moreau's plantation, 450 meters from river and 150 meters from Clay Bayou in the woods, 150 meters southwest of fence corner back of Valcour Moreau's house. Elevation, 33.05.

Stone $\frac{36}{2}$: Is on Valcour Moreau's plantation, 50 meters from right bank, 25 meters above fence, and 40 meters south of house. Elevation, 33.92.

Stone $\frac{36}{3}$: Is on James W. Land's plantation, 50 meters from left bank in the northeast corner of cabin yard at mouth of drain. Elevation, 34.39.

Stone $\frac{36}{4}$: Is on James W. Land's plantation, 100 meters south of ditch back in the woods, 200 meters northeast of cabin, near fence line on back of plantation. Elevation, 33.52.

*Stone line No. 37.—One-half mile above mouth of Boggy Bayou.*

Stone $\frac{37}{1}$: Is back in the woods, on Bartlett and La Croix place, near fence line across point, 10 meters from corner of fence, about halfway across. Elevation, 34.37.

Stone $\frac{37}{2}$: Is near the upper corner of Bartlett and La Croix place, 50 meters from right bank and 75 meters west of cabin. Elevation, 34.58.

Stone $\frac{37}{3}$: Is across from upper line of Bartlett and La Croix place, on grassy point, 40 meters from left bank and 150 meters east from cabin, one-half mile above mouth of Boggy Bayou. Elevation, 33.43.

Stone $\frac{37}{4}$: Is 300 meters from left bank, one-half mile above Boggy Bayou, in heavy timber, 30 meters from left bank of the second small bayou in the point. Elevation, 32.66.

*Stone line No. 38.—One and eight-tenths miles below Colfax.*

Stone $\frac{38}{1}$: Is on the Old Calhoun plantation, 400 meters from main right top bank in field, 50 meters from bend in small bayou, 200 meters from where it heads near road running by plantation house. Elevation, 34.36.

Stone $\frac{38}{2}$: Is on the Thorpe place, 45 meters from right bank, 50 meters above where first bank turns south, where a large bar has formed, and 75 meters north of cabin. Elevation, 36.56.

Stone $\frac{38}{3}$: Is on McNeely's part of the Old Calhoun plantation, on main bank 50 meters from river, halfway between mouth of bayou and where main bank begins, 40 meters along main bank from road down the river. Elevation, 36.93.

Stone $\frac{38}{4}$: Is on McNeely's part of the old Calhoun plantation, 10 meters from bayou bank, 400 meters up from river, and 150 meters above a cabin on the opposite side of bayou. Elevation, 36.04.

*Stone line No. 39.—Six hundred and fifty meters above L'eau Vernon Bayou.*

Stone $\frac{39}{1}$: Is on R. L. Carnahan's place, near middle of long field, 200 meters above the lower corner. Elevation, 34.43.

Stone $\frac{39}{2}$: Is on Dr. Philip Goode's place, 35 meters from fence, 40 meters above corner of lane below the house. Elevation, 36.21.

Stone $\frac{39}{3}$: Is on plantation belonging to Citizens' Bank of New Orleans, 25 meters from fence just back of cabin, 450 meters below church. Elevation, 36.14.

Stone $\frac{39}{4}$: Is on plantation belonging to Citizens' Bank of New Orleans, 700 meters from river, 150 meters northwest of first cabin near fence, counting from river along lower fence line. Elevation, 34.55.

*Stone line No. 40.—One and one-half miles below Fairmont.*

Stone $\frac{40}{1}$: Is on Goodwin and Carnahan's plantation, 50 meters from edge of woods, 100 meters above where division fence between Goodwin and Carnahan and Albert Goodwin's plantations enters woods, back of cabin on Albert Goodwin's plantation. Elevation, 31.53.

Stone $\frac{40}{2}$: Is on Goodwin and Carnahan's plantation, 20 meters above division fence along cottonwood woods, 125 meters below hay warehouse at Spears Landing. Elevation, 32.44.

Stone $\frac{40}{3}$: Is on J. M. Rhorer's plantation, outside of yard fence, 30 meters from corner on east side of dwelling. Elevation, 35.95.

Stone $\frac{40}{4}$: Is on G. W. Hickman's plantation, in pasture near garden fence, 100 meters west of house. Elevation, 34.33.

### *Stone line No. 41.—One-fourth mile above Boyce, La.*

Stone $\frac{41}{1}$: Is on Henry Boyce's plantation, 500 meters from river at mouth of Bayou Cotile or Jean de Jean, 25 meters southeast of house, 225 meters from bayou. Elevation, 34.54.

Stone $\frac{41}{2}$: Is on Henry Boyce's plantation, 75 meters from right bank at mouth of Bayou Cotile or Jean de Jean, on inside of fence, 250 meters above several cabins, 200 meters above Boyce, La. Elevation, 34.64.

Stone $\frac{41}{3}$: Is on T. K. Smith's plantation, 50 meters from left bank, near the middle of small pasture lot, 75 meters northwest of dwelling. Elevation, 34.28.

Stone $\frac{41}{4}$: Is on T. K. Smith's plantation, 625 meters from river, 350 meters southeast of gin. Elevation, 33.60.

### *Stone line No. 42.—One-fourth mile below Sullivan or Bertrand Landing.*

Stone $\frac{42}{1}$: Is on plantation of the Citizens' Bank of New Orleans, in heavy woods, 70 meters from Texas and Pacific Railroad track, 775 meters below west end of bridge over Bayou Bertrand, or 300 meters east of double ditch. Elevation, 31.47.

Stone $\frac{42}{2}$: Is on plantation of the Citizens' Bank of New Orleans, 50 meters from river, and 25 meters above corner of fence, 300 meters above Bayou Bertrand. Elevation, 32.82.

Stone $\frac{42}{3}$: Is on ——— Jeffries' plantation, at foot of main bank at upper end of large bar opposite mouth of Bayou Bertrand, and 150 meters above corner of plantation store. Elevation, 31.68.

Stone $\frac{42}{4}$: Is on ——— Jeffries' plantation, 375 meters northeast of plantation store on bank of Dry Bayou, 100 meters below a cabin on same bank. Elevation, 32.09.

### *Stone line No. 43.—One-fourth mile below mouth Motto Bayou.*

Stone $\frac{43}{1}$: Is on Leonard McGruder's plantation, 425 meters from river, in field, 275 meters northeast of cabin in corner of lane and cross fence. Elevation, 31.80.

Stone $\frac{43}{2}$: Is on William Isle's place, 40 meters from right bank, 75 meters above end of lower division fence. Elevation, 32.23.

Stone $\frac{43}{3}$: Is on ——— Jeffries' "Avoca" plantation, on south side of fence, 225 meters above lower corner of fence where it turns into the heavy timber. Elevation, 31.42.

Stone $\frac{43}{4}$: Is on ——— Jeffries' "Avoca" plantation, on south bank of fork of Motto Bayou, 250 meters above plantation quarters. Elevation, 30.81.

### *Stone line No. 44.—One-half mile above Waters Landing.*

Stone $\frac{44}{1}$: Is on E. J. Barrett's place, at bend in fence along woods, 150 meters back of gin. Elevation, 30.09.

Stone $\frac{44}{2}$: Is on E. J. Barrett's place, 75 meters from right bank, on right bank of slough, 125 meters below corner of fence at beginning of lane. Elevation, 29.82.

Stone $\frac{44}{3}$: Is on E. J. Barrett's place, on left bank, 50 meters from river, in pasture, 20 meters from Cherokee hedge, and 75 meters west of large barn. Elevation, 31.90.

### *Stone line No. 45.—One mile below Swilly Landing.*

Stone $\frac{45}{1}$: Is on Maj. Fred. Seip's plantation at foot of Texas and Pacific Railroad embankment, 325 meters below where levee from river crosses roadbed. Elevation, 30.89.

Stone $\frac{45}{2}$: Is on Maj. Fred. Seip's plantation, 55 meters from right bank, in grove of scattering trees, 125 meters below end of levee forming division line between Seip's and Meyer's plantations. Elevation, 29.91.

Stone $\frac{45}{3}$: Is in woods, 100 meters from left bank, 175 meters below mouth of a small bayou, 1 mile below Swilly Landing. Elevation, 31.09.

Stone $\frac{45}{4}$: Is in woods, 370 meters from river, 175 meters below mouth of a small bayou 1 mile below Swilly Landing. Elevation, 30.25.

### *Stone line No. 46.—One-half mile above Alexandria, La.*

Stone $\frac{46}{1}$: Is on the island formed by bayous Rapides, Cross, and Phillip, 50 meters east of angle in levee, 150 meters above junction of Cross Bayou and Bayou Rapides. Elevation, 29.42.

Stone $\frac{46}{2}$: Is in yard of the Texas and Pacific Railroad incline landing, 100 meters northwest of freight depot and 25 meters from northwest corner of yard. Elevation, 30.23.

**Stone $\frac{46}{3}$:** Is 75 meters from left bank, 25 meters from corner of yard of the first cabin below drain between the two old fort sites above Alexandria. Elevation, 31.05.

**Stone $\frac{46}{4}$:** Is 450 meters from river on spur of hill between the two old fort sites just back of the quarry above Alexandria. Elevation, 38.17.

### *Stone line No. 47.—Three and one-half miles below Alexandria.*

**Stone $\frac{47}{1}$:** Is on Mrs. S. W. Caruth's plantation, 40 meters from fence, between pasture and field, on pasture side, 100 meters southeast of large barn in northeast corner of pasture. Elevation, 29.34.

**Stone $\frac{47}{2}$:** Is on Alfred Neal's plantation, 10 meters from fence line along road and 25 meters from levee, 225 meters below mouth of division lane between Alfred Neal's and Mrs. S. W. Caruth's plantations. Elevation, 29.05.

**Stone $\frac{47}{3}$:** Is one-fourth mile below James Bluffs, ——— Ryland's place, 50 meters from left bank, 250 meters below Centennial (Ryland) Landing. Elevation, 28.53.

**Stone $\frac{47}{4}$:** Is one-fourth mile below James Bluffs, on——— Ryland's place, 425 meters from left bank, 250 meters below Centennial (Ryland) Landing, and is 40 meters from lower fence line along edge of timber. Elevation, 27.73.

### *Stone line No. 48.—At upper end of Grand Bend.*

**Stone $\frac{48}{1}$:** Is on S. Peart's "Grand Bend" plantation, in pasture, 50 meters from back fence, 300 meters above the lower corner. Elevation, 28.55.

**Stone $\frac{48}{2}$:** Is on S. Peart's "Grand Bend" plantation, 25 meters on outside of levee, near a few large cottonwood trees, 300 meters below a deserted cabin at upper end of Grand Bend. Elevation, 29.56.

**Stone $\frac{48}{3}$:** Is on Mrs. Lizzie Peart's place, 50 meters from left bank in pasture, 30 meters from levee, 150 meters below a cabin at foot of hills. Elevation, 28.74.

**Stone $\frac{48}{4}$:** Is on Col. J. C. Wise's plantation, 525 meters from left bank on side of hill near road, 300 meters back from lane where it enters woods. Elevation, 40.42.

### *Stone line No. 49.—Rogers Landing.*

**Stone $\frac{49}{1}$:** Is on Rogers's plantation, on the east bank of Choctaw Bayou, 125 meters from levee, at the northwest corner of cabin yard back of dwelling. Elevation, 28.33.

**Stone $\frac{49}{2}$:** Is at Rogers Landing, on the east bank of Choctaw Bayou, 75 meters west of warehouse and 50 meters on the outside from levee. Elevation, 28.35.

**Stone $\frac{49}{3}$:** Is a small field opposite Rogers Landing, belonging to J. Hathorne, 60 meters from left bank, 125 meters southeast of cabin in corner of field. Elevation, 28.82.

**Stone $\frac{49}{4}$:** Is in a small field opposite Rogers Landing, belonging to J. Hathorne, 25 meters diagonally out from northeast corner of field. Elevation, 28.

### *Stone line No. 50.—Jones Quarter Landing.*

**Stone $\frac{50}{1}$:** Is on Miss Josephine Jones's plantation, in the edge of bushes, 25 meters from division line between Jones's and Smith's plantations, 100 meters south of P. Smith's residence. Elevation, 27.02.

**Stone $\frac{50}{2}$:** Is in front of Polyte Smith's residence, 25 meters from the levee, in a small skirt of cottonwood trees. Elevation, 27.51.

**Stone $\frac{50}{3}$:** Is on the left bank in heavy woods, 125 meters below warehouse at Jones Quarter Landing, 50 meters from river at foot of ridge which forms the bank. Elevation, 26.40.

**Stone $\frac{50}{4}$:** Is on the left bank in heavy gum woods, 125 meters below warehouse at Jones Quarter Landing, 200 meters from three blazed gum trees. First tree is 10 meters southwest; second tree is 8 meters south, and third tree 2 meters west. Elevation, 25.58.

### *Stone line No. 51.—One mile below Beaver Dam Landing.*

**Stone $\frac{51}{1}$:** Is on George Dorman's plantation, near fence line at back of pasture, 100 meters east of corner of fence. A blazed willow is 35 meters east, and two blazed sycamores, one south, the other west. Elevation, 26.56.

**Stone $\frac{51}{2}$:** Is on George Dorman's plantation, 50 meters from levee, 75 meters from fence above gin and 200 meters northwest of residence. Elevation, 27.04.

**Stone $\frac{51}{3}$:** Is on Stonewall plantation, 1 mile below Beaver Dam Landing, 50 meters from left bank, 350 meters above cabin. A large blazed cottonwood stands 20 meters south. Elevation, 27.97.

Stone $\frac{51}{4}$: Is on Stonewall plantation, 1 mile below Beaver Dam Landing, 275 meters from the river in the back edge of clearing, 400 meters northwest of cabin, marked by three blazed cottonwood trees. First tree, 4 meters southwest; second tree, 1 meter west; third tree, 5 meters southeast. Elevation, 25.74.

### *Stone line No. 52.—New Ash Landing.*

Stone $\frac{52}{1}$: Is on F. M. Joffrion's plantation, in the edge of woods skirting a small drain, 200 meters west of residence and 40 meters above fence. Elevation, 26.04.

Stone $\frac{52}{2}$: Is on F. M. Joffrion's plantation, on an old levee 100 meters north of angle in main levee in front of residence. Elevation, 27.93.

Stone $\frac{52}{3}$: Is on John Harris's (colored) place at New Ash Landing, 50 meters from left bank, 10 meters from right bank of bayou, 25 meters from division line between Harris and Scott plantations. Elevation, 26.63.

Stone $\frac{52}{4}$: Is on John Harris's (colored) place at New Ash Landing, 150 meters from river, on the side of hill near fence line dividing Harris and Scott places. Elevation, 27.64.

### *Stone line No. 53.—One mile below New Poland Landing.*

Stone $\frac{53}{1}$: Is on Hatch's plantation, 250 meters southeast of James Lucas's (colored) cabin in cottonwood woods, marked by a blazed cottonwood 8 meters southeast and a blazed cottonwood 12 meters southwest. Elevation, 27.17.

Stone $\frac{53}{2}$: Is on James Lucas's (colored) place, 60 meters from right bank, near lower fence line, 80 meters east of cabin. Elevation, 27.30.

Stone $\frac{53}{3}$: Is on James Ellis's (colored) place, 50 meters from left bank, 60 meters below where woods come to river bank; marked by two blazed willows 6 and 5 meters southwest, a blazed cypress 7 meters west, and a blazed cypress 3 meters northeast. Elevation, 26.18.

Stone $\frac{53}{4}$: Is on James Ellis's (colored) place, 175 meters back in low cypress swamp, and 60 meters below where woods come to river bank; marked by a blazed cypress 7 meters southwest on a path, a blazed cypress 4 meters northwest, and a blazed cypress 1 meter north. Elevation, 24.62.

### *Stone line No. 54.—One-half mile below Once More Landing.*

Stone $\frac{54}{1}$: Is on George Wilson's plantation, 250 meters from river, near fence in edge of swamp, 200 meters southwest of cabin. Elevation, 24.04.

Stone $\frac{54}{2}$: Is on George Wilson's plantation, on the inside of fence along road one-half mile below residence. Elevation, 25.64.

Stone $\frac{54}{3}$: Is on J. Grimes's plantation, on the point called "Ingleside;" is 50 meters from river above a small clump of trees north of house. Elevation, 26.82.

Stone $\frac{54}{4}$: Is on J. Grimes's plantation, on the point called "Ingleside;" 40 meters from left bank, near fence line; 40 meters from the corner of fence, on parish line opposite Lookout Landing. Is 225 meters from $\frac{54}{3}$. Elevation, 26.76.

### *Stone line No. 55.—One-half mile above Egg Bend.*

Stone $\frac{55}{1}$: Is on Jackson plantation, near a plantation road 200 meters south of Kalon's dwelling. Marked by a blazed persimmon tree 15 meters northeast. Elevation, 25.

Stone $\frac{55}{2}$: Is at outside foot of levee on Jackson plantation, 80 meters northwest of Kalon's dwelling. Marked by a blazed locust 15 meters northwest and a blazed sycamore 45 meters northeast. Elevation, 26.

Stone $\frac{55}{3}$: Is on J. Grimes's plantation, ½ mile above Egg Bend, 50 meters from left bank, in the woods. Marked by a blazed oak tree 4 meters southeast and a blazed ash 7 meters northwest. Elevation, 26.23.

Stone $\frac{55}{4}$: Is on J. Grimes's plantation, ½ mile above Egg Bend, 150 meters from left bank, in the woods near a dry lake bed. Marked by a blazed willow 15 meters east and a blazed oak 5 meters southeast. Elevation, 24.29.

### *Stone line No. 56.—Innis Bluffs.*

Stone $\frac{56}{1}$: Is on O. Lachenay's plantation, in the edge of woods at the junction of four fences, 400 meters south of house. Elevation, 23.86.

Stone $\frac{56}{2}$: Is on O. Lachenay's plantation, on the inside of fence along road, ½ mile above residence, opposite Innis Bluffs. Elevation, 25.31.

Stone ${}^{5}_{3}{}^{6}$: Is at foot of Innis Bluffs, 30 meters from left bank and 100 meters north of house. A blazed pecan tree stands 16 meters southwest. Elevation, 25.19.

Stone ${}^{5}_{4}{}^{6}$: Is at Innis Bluffs, on the side of hill, 15 meters from corner of fence, 250 meters northwest of house. A blazed gum tree is 10 meters north. Elevation, 26.95.

### *Stone line No. 57.—Cassandria.*

Stone ${}^{5}_{1}{}^{7}$: Is on F. Laborde's plantation, 250 meters above where wood line comes to river and 50 meters back in the woods, opposite Cassandria. Elevation, 24.16.

Stone ${}^{5}_{2}{}^{7}$: Is on F. Laborde's plantation, 50 meters from right bank, opposite gin at Cassandria. Elevation, 25.37.

Stone ${}^{5}_{3}{}^{7}$: At Cassandria, on M. I. Ryland's plantation, 50 meters west of gin and 100 meters north of warehouse. Elevation, 25.25.

Stone ${}^{5}_{4}{}^{7}$: Is on M. I. Ryland's plantation, on inside of fence upon the hill along the road leading north from Cassandria, 100 meters from the west corner of field. Elevation, 29.32.

### *Stone line No. 58.—Louisiana Experiment Station plantation.*

Stone ${}^{5}_{1}{}^{8}$: Is on Cannon's place, on the left bank of bayou, 200 meters below fence and 300 meters southeast of house. A blazed cottonwood is 10 meters south. Elevation, 24.62.

Stone ${}^{5}_{2}{}^{8}$: Is on Cannon's place, 25 meters northeast of house, at upper corner of farm. Elevation, 24.90.

Stone ${}^{5}_{3}{}^{8}$: Is on the Experiment Station plantation, on the part owned by Baker Brothers, on the inside of fence along roadside, 150 meters below the dwelling at head of Cay Bayou. Elevation, 24.13.

Stone ${}^{5}_{4}{}^{8}$: Is on the Experiment Station plantation, on the part owned by Baker Brothers, on the right bank of Cay Bayou, 325 meters below dwelling. A blazed willow is 10 meters southwest and a blazed pecan 3 meters north. Elevation, 23.73.

### *Stone line No. 59.—One-fourth mile above Laborde Landing.*

Stone ${}^{5}_{1}{}^{9}$: Is on Johnson's place, in middle of point of woods opposite Laborde Landing, 175 meters from right bank. Marked by a blazed hackberry 1 meter southeast and a blazed cottonwood 12 meters southwest. Elevation, 22.91.

Stone ${}^{5}_{2}{}^{9}$: Is on Johnson's place, 450 meters above Laborde Landing, 50 meters from right bank, in the woods. A blazed sycamore is 2½ meters southeast and a blazed sycamore 5 meters northwest. Elevation, 24.26.

Stone ${}^{5}_{3}{}^{9}$: Is on P. J. Laborde's place, on the inside of fence in a small field, 50 meters southeast of deserted cabin, 400 meters above Laborde Landing. A blazed cottonwood is 20 meters west. Elevation, 24.46.

Stone ${}^{5}_{4}{}^{9}$: Is on P. J. Laborde's place, in edge of woods along the fence at back of small field, 150 meters north of deserted cabin, 400 meters above Laborde's Landing. Marked by three blazed cottonwood trees; one 12 meters southwest, another 15 meters southeast, and the third 2 meters northwest. Elevation, 24.06.

### *Stone line No. 60.—Three-fourths mile above Normand Landing.*

Stone ${}^{6}_{1}{}^{0}$: Is on A. Dauzat's place, 600 meters above cabin, 150 meters from right bank, in a swamp. Marked by blazed willows. Elevation, 21.54.

Stone ${}^{6}_{2}{}^{0}$: Is on A. Dauzat's place, 600 meters above cabin, 50 meters from right bank. A blazed pecan tree is 3 meters northwest, a blazed oak 5 meters north, and blazed oak 6 meters south. Elevation, 22.17.

Stone ${}^{6}_{3}{}^{0}$: Is on deserted place of H. Edwards, 40 meters from left bank, 125 meters north of where timber line comes to river, and 75 meters south of deserted cabin. Elevation, 24.23.

Stone ${}^{6}_{4}{}^{0}$: Is on deserted place of H. Edwards, 225 meters from left bank in edge of woods, 275 meters east of cabin. A blazed sycamore is 8 meters southwest; a blazed sycamore is 1 meter north, and a blazed ash 3 meters south. Elevation, 23.63.

### *Stone line No. 61.—Barbin Landing.*

Stone ${}^{6}_{1}{}^{1}$: Is on E. Barbin's place, 100 meters from lane on a ditch, 210 meters northeast of cabin in corner of place near bridge over Gordon Bayou. A blazed willow on ditch is 5 meters southeast. Elevation, 22.23.

Stone ${}^{6}_{2}{}^{1}$: At Barbin Landing, on E. Barbin's place, on the inside of fence along the road, 15 meters below corner of lane, 30 meters southeast of warehouse. Elevation, 23.64.

Stone $\frac{61}{3}$: Is on Coco's place, opposite Barbin Landing, on the inside of fence 100 meters below double cabin. Elevation, 23.54.

Stone $\frac{61}{4}$: Is on Coco's place, opposite Barbin Landing, at back fence line of small field, 250 meters northeast of double cabin. Marked by blazed cottonwoods 5 meters north and 5 meters southeast on opposite sides of fence. Elevation, 22.04.

*Stone line No. 62.—Three and one-fourth miles below Barbin Landing.*

Stone $\frac{62}{1}$: Is on J. Bettevy's place, near cross fence line, 15 meters above the junction of fences, 100 meters above mouth of lane between Bettevy's and George's places. Elevation, 22.85.

Stone $\frac{62}{2}$: Is on J. Bettevy's place, 25 meters from fence, 35 meters below upper front fence corner. Elevation, 23.28.

Stone $\frac{62}{3}$: Is on ——— Noguez' (colored) place, opposite Bettevy's place, 50 meters from left bank, 350 meters above lower fence line. Elevation, 23.34.

Stone $\frac{62}{4}$: Is on ——— Noguez' (colored) place, 25 meters from left bank, 275 meters below cabin. Elevation, 23.24.

*Stone line No. 63.—Upper end of Saline Point.*

Stone $\frac{63}{1}$: Is on Mayer's place, on the left bank of a small bayou, 300 meters from river at lower front fence corner of L. Juneau's place near end of levee. Reference trees five willows as follows: 30 meters east; 2 meters northeast; 5 meters northwest; 5 meters south of west; 6 meters west of south. Elevation, 22.34.

Stone $\frac{63}{2}$: Is on Mayer's place, 50 meters from right bank on side of road leading around Saline Point, 500 meters below bend below L. Juneau's place. References: No. 1, 4-foot cottonwood, 12 meters northwest; No. 2, ash, 4 meters northwest; No. 3, sycamore, 6 meters southeast; No. 4, cottonwood, 12 meters southwest. Elevation, 23.12.

Stone $\frac{63}{3}$: Is on Mayer's place, 50 meters from left bank at foot of slope, 45 meters north of deserted cabin in small clearing. Elevation, 22.94.

Stone $\frac{63}{4}$: Is on Mayer's place, 225 meters from river northwest of deserted cabin in small clearing. References: No. 1, cottonwood, 7 meters south; No. 2, willow 8 meters south; No. 3, cottonwood, 2 meters west No. 4, willow, 3 meters east. Elevation, 21.78.

*Stone line No. 64.—One-half mile below mouth of Saline Bayou.*

Stone $\frac{64}{1}$: Is 100 meters from right bank opposite mouth of Saline Bayou. References: No. 1, willow, 5 meters north; No. 2, willow, 10 meters northeast; No. 3, willow, 15 meters southeast. Elevation, 22.04.

Stone $\frac{64}{2}$: Is 75 meters from right bank, 500 meters from point below mouth of Saline Bayou. Elevation, 22.39.

Stone $\frac{64}{3}$: Is 100 meters from left bank, ½ mile below mouth Saline Bayou. References: No. 1, 3 meters north, 30° east; No. 2, 6 meters south, 80° east; No. 3, 7 meters south, 10° west; No. 4, 5 meters south, 60° west. Elevation, 22.58.

Stone $\frac{64}{4}$: Is 450 meters from left bank ½ mile below mouth Saline Bayou, 50 meters from Channel Lake. References: No. 1, 10 meters north, 60° west; No. 2, 8 meters south 50° west. Elevation, 19.60.

*Stone line No. 65.—Head of Bayou Lenoir.*

Stone $\frac{65}{1}$: Is on Barbin's land, 500 meters from river at lower point of large sand bar at head of Bayou Lenoir. References: No. 1, 12 meters south, 70° east; No. 2, 15 meters south, 20° east; No. 3, south, 10° east; No. 4, 8 meters south, 20° west. Elevation, 20.57.

Stone $\frac{65}{2}$: Is on Barbin's land, 100 meters from river at lower point of large sand bar at head of Bayou Lenoir. References: No. 1, 10 meters south; No. 2, 5 meters south, 50° east; No. 3, 12 meters north, 40° east; No. 4, 6 meters north, 80° west. Elevation, 22.35.

Stone $\frac{65}{3}$: Is on La Pary's place, 100 meters from left bank at the point opposite Bayou Lenoir. References: No. 1, 16 meters south, 10° east; No. 2, 15 meters south, 70° east; No. 3, 6 meters south, 30° west. Elevation, 21.81.

Stone $\frac{65}{4}$: is on La Pary's place, 500 meters from river at the point opposite Bayou Lenoir, and 50 meters from Mitten Lake. References: No. 1, 4 meters south, 40° east; No. 2, 12 meters east; No. 3, 25 meters north, 40° west; No. 4, 15 meters south, 40° west. Elevation, 21.01.

### *Stone line No. 66.—One and three-fourths miles above mouth of Lake Latania.*

Stone $^{66}_{1}$: Is on right bank, 525 meters from river, in something of a dry lake bed below Paulk Lake. References: No. 1, 15 meters south, 40° east; No. 2, 12 meters south, 80° east; No. 3, 8 meters north; No. 4, 5 meters north, 70° west. Elevation, 19.44.

Stone $^{66}_{2}$: Is 90 meters from right bank, 1¾ miles above mouth of Lake Latania and 150 meters below mouth of small bayou. References: No. 1, 10 meters south, 60° east; No. 2, 5 meters north, 20° east; No. 3, 16 meters south, 20° west. Elevation, 21.45.

Stone $^{66}_{3}$: Is 75 meters from left bank, 1¾ miles above mouth of Lake Latania. References: No. 1, 15 meters south, 40° east; No. 2, 6 meters north, 40° east; No. 3, 8 meters north, 80° west. Elevation, 21.36.

Stone $^{66}_{4}$: Is 350 meters from river, 50 meters from prong of lake, 1¾ miles above mouth of Lake Latania. References: No. 1, 4 meters south, 40° east; No. 2, 6 meters north, 40° east; No. 3, 8 meters south, 10° west. Elevation, 18.85.

### *Stone line No. 67.—Two miles below head of Bayou Natchitoches.*

Stone $^{67}_{1}$: Is 400 meters from right bank, 2 miles below head of Bayou Natchitoches. References: No. 1, 12 meters south, 30° east; No. 2, 3 meters north, 70° east; No. 3, 15 meters north, 80° west. Elevation, 20.25.

Stone $^{67}_{2}$: Is 75 meters from right bank, 2 miles below head of Bayou Natchitoches. References: Blazed saplings. Elevation, 20.40.

Stone $^{67}_{3}$: Is 100 meters from left bank at foot of main bank, 2 miles below head of bayou. References: No. 1, 15 meters south; No. 2, 25 meters south, 60° east; No. 3, 6 meters north, 10° west; No. 4, 2 meters south, 70° west. Elevation, 19.24.

Stone $^{67}_{4}$: Is 450 meters from river on main bank, 2 miles below head of Bayou Natchitoches. References: No. 1, 8 meters south, 30° east; No. 2, 4 meters south, 80° east; No. 3, 3 meters north; No. 4, 5 meters south, 50° west. Elevation, 20.50.

### *Stone line No. 68.—Cammack Landing.*

Stone $^{68}_{1}$: Is 525 meters from right bank and 40 meters on the farther side from a slough lake opposite Cammack Landing. References: No. 1, 6 meters south, 70° east; No. 2, 5 meters south, 85° east; No. 3, 3 meters south; No. 4, 3 meters north, 30° east. Elevation, 18.66.

Stone $^{68}_{2}$: Is 125 meters from right bank opposite Cammack Landing. References: No. 1, 6 meters east; No. 2, 8 meters north, 50° east; No. 3, 8 meters south, 80° west. Elevation, 20.00.

Stone $^{68}_{3}$: At Cammack Landing, 100 meters from left bank and 50 meters from fence corner on outside of fence line west of residence. Elevation, 21.22.

Stone $^{68}_{4}$: Is on Cammack's place, 750 meters from river in the woods back of small field, 150 meters a little east of north from back west corner of field. References: No. 1, 5 meters south, 80° east; No. 2, 10 meters north, 70° east. Elevation, 21.55.

### *Stone line No. 69—Two miles above mouth of Black River.*

Stone $^{69}_{1}$: Is on C. Jeannette's (colored) place, 425 meters from river and 175 meters from fence back of cabin. References: No. 1, 15 meters south, 30° east; No. 2, 5 meters north, 80° east; No. 3, 7 meters north, 30° west; No. 4, 6 meters south, 65° west. Elevation, 20.61.

Stone $^{69}_{2}$: Is on C. Jeannette's (colored) place, 100 meters from right bank in field, 50 meters south of cabin. Elevation, 21.25.

Stone $^{69}_{3}$: Is 100 meters from left bank 50 meters below C. Jeannette's (colored) cabin. References: No. 1, 10 meters south, 40° east; No. 2, 10 meters north, 50° east; No. 3, 8 meters north; No. 4, 6 meters north, 60° west. Elevation, 18.84.

Stone $^{69}_{4}$: Is 425 meters from river, 50 meters below C. Jeannette's (colored) cabin, on small ridge between two slough lakes, 200 meters below their fork. References: No. 1, 15 meters west; No. 2, 10 meters south, 20° west. Elevation, 19.15.

### *Stone line No. 70.—One-half mile below "2-mile" Bayou.*

Stone $^{70}_{1}$: Is 700 meters from right bank, one-half mile below "2-mile" Bayou, or 482.8 miles from Fulton, Ark. References: No. 1, 8 meters south, 70° east; No. 2, 15 meters north, 20° east; No. 3, 18 meters north, 70° west; No. 4, 15 meters south, 20° west. Elevation, 18.15.

Stone $^{70}_{2}$: Is 75 meters from right bank, one-half mile below "2-mile" Bayou or

482.8 miles from Fulton, Ark. References: No. 1, 20 meters south, 80° east; No. 2, 8 meters north; No. 3, 15 meters west. Elevation, 19.30.

Stone $\frac{70}{3}$: Is 60 meters from left bank on main bank, one-half mile below "2-mile" Bayou, or 482.8 miles from Fulton, Ark. References: No. 1, 4 meters south, 50° east; No. 2, 8 meters east; No. 3, 5 meters north; No. 4, 10 meters north, 80° west. Elevation, 19.65.

Stone $\frac{70}{4}$: Is 525 meters from left bank, ½ mile below "2-mile" Bayou, or 482.8 miles from Fulton, Ark. References: No. 1, 10 meters south, 60° east; No. 2, 70 meters north, 20° east; No. 3, 8 meters north, 70° west; No. 4, 15 meters south, 10° west. Elevation, 19.25.

### *Stone line No. 71.—One-half mile above "7-mile" Bayou.*

Stone $\frac{71}{1}$: Is in the swamp, 675 meters from right bank, ½ mile above "7-mile" Bayou, or 487.1 miles from Fulton, Ark. References: No. 1, 10 meters south, 30° east; No. 2, 17 meters south, 80° east; No. 3, 3 meters north; No. 4, 15 meters west; No. 5, 12 meters south, 40° west. Elevation, 17.46.

Stone $\frac{71}{2}$: Is 100 meters from right bank, ½ mile above "7-mile" Bayou, or 487.1 miles from Fulton, Ark. References: No. 1, 5 meters south, 40° east; No. 2, 10 meters north, 30° east; No. 3, 10 meters north, 50° west; No. 4, 6 meters west; No. 5, 12 meters south, 10° west. Elevation, 19.80.

Stone $\frac{71}{3}$: Is 50 meters from left bank on small second bank of small bayou, ½ mile above "7-mile" Bayou, or 487.1 miles from Fulton, Ark. References: No. 1, 3 meters south, 60° east; No. 2, 15 meters north, 50° east; No. 3, 10 meters north, 70° west. Elevation, 19.15.

Stone $\frac{71}{4}$: Is 525 meters from left bank at mouth of small bayou, ½ mile above "7-mile" Bayou, or 487.1 miles from Fulton, Ark. References: No. 1, 5 meters south; No. 2, 15 meters north, 50° east; No. 3, 15 meters north; No. 4, 20 meters west. Elevation, 16.92.

### *Stone line No. 72.—One mile above mouth of Bayou Cocodrie.*

Stone $\frac{72}{1}$: Is 450 meters from right bank, 1 mile above mouth of Bayou Cocodrie. References: No. 1, 5 meters south, 30° east; No. 2, 12 meters south, 65° east; No. 3, 5 meters north, 35° east; No. 4, 6 meters north, 30° west. Elevation, 15.83.

Stone $\frac{72}{2}$: Is 50 meters from right bank, 1 mile above mouth of Bayou Cocodrie. References: No. 1, 14 meters south, 10° east; No. 2, 15 meters east; No. 3, 6 meters north, 15° west; No. 4, 7 meters north, 45° west. Elevation, 19.71.

Stone $\frac{72}{3}$: Is 50 meters from left bank, 1 mile above mouth of Bayou Cocodrie. References: No. 1, 3 meters south, 35° east; No. 2, 7 meters south, 75° east; No. 3, 10 meters north, 45° west; No. 4, 8 meters south, 70° west. Elevation, 16.50.

Stone $\frac{72}{4}$: Is 525 meters from left bank, 1 mile above mouth of Bayou Cocodrie and 25 meters from right bank of Bayou Cocodrie. References: No. 1, 2 meters south, 20° east; No. 2, 15 meters north, 50° east; No. 3, 5 meters north, 30° east; No. 4, 15 meters south, 80° west. Elevation, 15.2.

### *Stone line No. 73.—One-fourth mile above mouth of Bayou Natchitoches.*

Stone $\frac{73}{1}$: Is 625 meters from right bank one-fourth mile above mouth of Bayou Natchitoches, and is 75 meters from the west bank of Red River Bay, 550 meters above its mouth. References: No. 1, 15 meters south, 60° east; No. 2, 6 meters north, 30° east; No. 3, 8 meters south, 25° west. Elevation, 15.44.

Stone $\frac{73}{2}$: Is 30 meters from right bank, 500 meters above mouth of Bayou Natchitoches. References: No. 1, 6 meters north, 60° east; No. 2, 15 meters north, 35° east; No. 3, 10 meters north, 50° west; No. 4, 10 meters south, 70° west. Elevation, 16.34.

Stone $\frac{73}{3}$: Is 40 meters from left bank, 500 meters above mouth of Bayou Natchitoches: References: No. 1, 6 meters east; No. 2, 5 meters north, 45° east; No. 3, 5 meters west; No. 4, 8 meters south, 20° west. Elevation, 19.39.

Stone $\frac{73}{4}$: Is 450 meters from left bank, 500 meters above mouth of Bayou Natchitoches, and 150 meters south of small bayou. References: No. 1, 15 meters north, 70° east; No. 2, 12 meters north, 35° east; No. 3, 5 meters west; No. 4, 6 meters south, 40° west. Elevation, 16.22.

### *Stone line No. 74.—Marcotte Landing.*

Stone $\frac{74}{1}$: Is 550 meters from Marcotte Landing, on bank of Marcotte Lake at point. References: No. 1, 5 meters south, 25° east; No. 2, 6 meters south, 75° east; No. 3, 5 meters north, 25° west; No. 4, 15 meters north, 50° west. Elevation, 17.00.

Stone $\frac{74}{2}$: Is 35 meters from right bank at foot of slope, 225 meters below old warehouse. Elevation, 18.44.

Stone $\frac{74}{3}$: Is 50 meters from left bank, 200 meters below Marcotte Landing. References: No. 1, 5 meters north, 80° east; No. 2, 4 meters north, 15° east; No. 3, 7 meters north, 60° west; No. 4, 5 meters south, 15° west. Elevation, 16.93.

Stone $\frac{74}{4}$: Is 575 meters from river, 200 meters below Marcotte Landing: References: No. 1, 12 meters south, 70° east; No. 2, 8 meters north, 60° east; No. 3, 8 meters north, 40° west; No. 4, 10 meters south, 30° west. Elevation, 16.26.

*Stone line No. 75.—Three-fourths mile above mouth of Red River.*

Stone $\frac{75}{1}$: Is 775 meters from right bank, at head of slough lake called Water Valley. References: No. 1, 15 meters south, 10° east; No. 2, 10 meters south, 60° east; No. 3, 5 meters north, 40° east; No. 4, 10 meters south, 50° east. Elevation, 18.36.

Stone $\frac{75}{2}$: Is 175 meters from right bank, across head of slough lake called Water Valley. References: No. 1, 6 meters north, 10° east; No. 2, 12 meters north, 85° west; No. 3, 6 meters south, 30° west. Elevation, 19.97.

Stone $\frac{75}{3}$: Is 75 meters from left bank, three-fourths mile above mouth of Red River, across on high ground between lower end of small lake and swamp. References: No. 1, 4 meters south, 45° east; No. 2, 20 meters north, 45° east; No. 3, 6 meters south, 10° west. Elevation, 16.59.

Stone $\frac{75}{4}$: Is 300 meters from left bank, three-fourths mile above mouth of Red River in swamp. References: No. 1, 6 meters south, 20° east; No. 2, 12 meters north, 25° west; No. 3, 3 meters south, 80° west. Elevation, 16.48.

### TABLE 6.—DESCRIPTIONS OF PERMANENT REFERENCE POINTS FROM FULTON, ARK., TO SHREVEPORT, LA.

[NOTE.—Elevations are given wherever determined and are expressed in meters above the Cairo datum. The elevations given apply to top of bolt in the underground stone. Elevation of boss of pipe cap can be found in any case by adding 1.24 meters to elevation of top of bolt.]

P. R. P. 1: At west end of Iron Mountain Railroad Bridge at Fulton, Ark.; between track and south wing wall of abutment and about 10 feet back of bridge seat. Reference points are the following: No. 1, bridge plate at west end of north truss of bridge, azimuth from P. R. P. is 200° 08′; No. 2, bridge plate at west end of south truss of bridge, azimuth from P. R. P. is 231° 05′; No. 3, west end of south wing wall of abutment, azimuth from P. R. P. is 295° 22′. Elevation, 87.01.

P. R. P. 2: Has been destroyed.

P. R. P. 3: On Smith's plantation; 900 feet from river and 2,000 feet below gin; in field 2 feet from fence. Reference trees: No. 1 is a 5-foot cottonwood, on an azimuth of 110° from P. R. P., and 32 feet distant; No. 2, 2-foot sycamore 251°, 53 feet; No, 3, 2-foot cypress, 313°, 20 feet. Elevation, 80.55.

P. R. P. 4: On Ferguson's plantation; left bank; about 1,400 feet below gin in deadening, 2 feet from fence, and about 400 feet from river bank. Reference trees: No. 1, 2-foot cottonwood, 130°, 46 feet; No. 2, 1-foot sycamore, 245°, 37 feet; No. 3, 1-foot sycamore, 317°, 27 feet. Elevation, 80.15.

P. R. P. 5: On right bank about 1,050 feet below clearing at lower end of Dr. Mill's plantation, and about 530 feet from river, and 380 feet back of wagon road passing in front of clearing. Reference trees: No. 1, 1-foot box elder, 334°, 17 feet; No. 2, 1-foot mulberry, 172°, 19 feet; No. 3, 2-foot cottonwood, 102°, 28 feet. Elevation, 79.78.

P. R. P. 6: On right bank; 3,600 feet below Sim's landing, 2,000 feet above Red Lake, and 400 feet from river. It is about opposite lower end of Henry Topp's plantation. Elevation, 79.42.

P. R. P. 7: On right bank; inside back levee near lower end of Woods' and Thaxler's plantation. References: No. 1, bend in levee, 120°, 10 feet; No. 2, 1-foot cottonwood, 142°, 17 feet; No. 3, 1-foot cottonwood, 161°, 25 feet. Elevation, 77.80.

P. R. P. 8: On right bank; on levee at upper end of Pearson's plantation, 1,500 feet from river, and 600 feet back from lower end of lake. Elevation, 77.00.

P. R. P. 9: Right bank; on levee at lower end of Pearson's plantation, near where levee enters woods. Elevation, 76.24.

P. R. P. 10: Right bank; at lower end of plantation owned by heirs of Merriman Murphy, in northeast corner of garden inclosure. References: No. 1, edge of Candler Lake, 291°, 39 feet; No. 2, 3-foot pin oak, 2°, 100 feet; No. 3, 3-foot red oak, 223°, 90 feet; No. 4, southeast corner of cabin, 149°, 60 feet. Elevation, 74.38.

P. R. P. 11: Right bank; on Dr. P. H. Candler's place, about 1 mile below plantation house; 2,800 feet from river and 3 feet north of crown of back levee. Reference trees: No. 1, 1½-foot elm, south side of levee, 7 feet; No. 2, 1-foot elm, north side of levee, 220° (about), 4 feet; No. 3, 2-foot elm, north side of levee, 290° (about), 14 feet. Elevation, 73.62.

P. R. P. 12: Left bank; on Armour's plantation, about 1,500 feet above gin and on crown of front levee. Reference trees: No. 1, 1½-foot cottonwood, 343°, 57 feet; No. 2, 1-foot cottonwood, 14°, 53 feet; No. 3, 1-foot elm, 63°, 29 feet. Elevation, 73.62.

P. R. P. 13: Right bank; near upper end of California plantation; 66 feet west of lower end of Nigger Lake, 32 feet back of levee, and 28 feet north of slough. References: No. 2, angle in levee, 287°, 51 feet; No. 3, angle in levee, 182°, 70 feet; No. 7, 2-foot cottonwood, 211°, 127 feet. Elevation, 71.69.

P. R. P. 14: Left bank; about 800 feet back of Jordan Landing and 500 feet south of Terrell Bayou; at corner of levee between Terrell's and Dixon's plantations. References: No. 1, 4-foot cottonwood, 147°, 200 feet; No. 2, southeast corner of cabin, 178°, 224 feet; No. 3, northeast corner of cabin, 75° 40′, 670 feet. Elevation, 72.07.

P. R. P. 15: Left bank; on Conway's or Long Prairie plantation, about 1,300 feet back of Conway's Landing; at intersection of two levees. References: No. 1, levee intersection, 82° 45′, 764 feet; No. 2, northeast corner of cabin, 42° 55′, 188 feet. Elevation, 71.90. Destroyed in 1892.

P. R. P. 16: Left bank; on Smith's Bend plantation; at edge of woods, 900 feet from river at upper end of bend, 1,000 feet from river at lower end of bend, and 2,000 feet above point where levee crosses neck. References: No. 1, southeast corner of cabin, 163° 20′, 578 feet; No. 2, 1-foot cottonwood, 177°, 13 feet; No. 3, cottonwood (in woods) 276°, 24 feet. Elevation, 70.36. Covered by deposit and marked by 1½-inch gas pipe.

P. R. P. 17: Left bank; in woods, about halfway between river and Anthony Lake and 900 feet below north end of lake. Reference trees: No. 1, 3-foot sweet gum, 327°, 57 feet; No. 2, 1-foot ash, 35°, 24 feet; No. 3, 1-foot box elder, 178°, 27 feet. Elevation, 69.21.

P. R. P. 18: Left bank; about 1 mile above mouth of Sulphur River; 200 feet from river and 115 feet back of road; about 450 feet above small cabin. It is in middle of "chain line cut" through the woods. Reference trees: No. 1½-foot cottonwood, 255°, 6 feet; No. 2, 1½-foot cottonwood, 174°, 36 feet; No. 3, 1-foot cottonwood, 132°, 23 feet; No. 4, 1-foot cottonwood, 87°, 33 feet. Elevation, 70.17.

P. R. P. 19: Right bank; 3 miles below Spring Bank; at foot of Diggs Bluff, which is the first point where river strikes the hills below Spring Bank. References: No. 1, 3-foot white oak, 220° (about), 40 feet; No. 2, 1-foot red oak, 180° (about), 70 feet; No. 3, southeast corner of old warehouse, 140° (about), 35 feet. Elevations, 70.04.

P. R. P. 20: Left bank; 3½ miles below Diggs Bluff; about one-half mile below point where river turns sharply to the left; 137 feet from river, and in heavy timber. Reference trees: No. 1, 5-foot cottonwood, 81°, 6 feet; No. 2, 3-foot cottonwood, 170°, 7 feet; No. 3, 1-foot sweet gum, 351°, 21 feet. Elevation, 71.39.

P. R. P. 21: Right bank; on side of bluff, about 500 feet above the Arkansas and Louisiana State line, 30 feet from foot of bluff and 75 feet from bank of bayou; back of Hunt's plantation. Reference trees: No. 1, 1½-foot ash, 288°, 24 feet; No. 2, 2-foot cottonwood, standing by fence near foot of bluff, 260°, 64 feet; No. 3, 1-foot red oak, 205°, 20 feet; No. 4, 1-foot hickory, 61°, 28 feet. Elevation, 70.81.

P. R. P. 22: Right bank; 90 feet south of south bank of Bargetown Slough and 900 feet from mouth of same, in old chain line cut. References: No. 1½-foot cottonwood, 151°, 25 feet; No. 2, 1-foot cottonwood, 3°, 13 feet; No. 3, 1½-foot cottonwood, 281°, 37 feet. Elevation 68.62.

P. R. P. 23: Left bank; at head of Boone Bend, opposite where neck of point is most narrow; 128 feet back from river, in old chain line cut. Reference trees: No. 1, 1½-foot cottonwood, 316°, 26 feet; No. 2, 1-foot cottonwood, 169°, 62 feet; No. 3, 1-foot cottonwood, 64°, 26 feet. Elevation, 68.24.

P. R. P. 24: Left bank; 80 feet from south side of Alban Canal No. 1 and about 450 feet from river. Reference trees: No. 1, 1-foot willow, 151°, 5 feet; No. 2, 1½-foot cottonwood, 343°, 7 feet; No. 3, 1-foot cottonwood, 247°, 13 feet. Elevation, 67.44.

P. R. P. 25: Left bank; 160 feet below Posten Bayou and 250 feet from river; at upper back corner of old clearing. Reference trees: No. 1, 1-foot ash, 120°, 23 feet; No. 2, 1-foot ash, 232°, 6 feet; No. 3, 2-foot cottonwood, 189°, 63 feet. Elevation, 66.77.

P. R. P. 26: Left bank; between Red River and Dutch Jan Lake; 320 feet above Fuller Inlet, 450 feet from river, and 150 feet from bank of Jan Lake, in old chain-like cut. Reference trees: No. 1, 1-foot sycamore, 70°, 24 feet; No. 2, 1-foot sycamore, 148°, 20 feet: No. 3, 2-foot cottonwood, 262°, 17 feet; No. 4, 2-foot cottonwood, 328°, 17 feet. Elevation, 66.32.

P. R. P. 27: On top of bluff, about 2,400 feet above Gilmer Landing, and just below mouth of Fuller outlet. Reference trees: No. 1, 1½-foot red oak, 311°, 10 feet; No. 2, 1-foot hickory, 204°, 22 feet; No. 3, ¾-foot black jack, 161°, 43 feet. Elevation, 78.68.

P. R. P. 28: On back levee, between Peru plantation and Dooley Bayou; about 2,000 feet from river, 300 feet from bayou, and 6,000 feet below head of bayou. Reference trees: No. 1, 1½-foot cottonwood, 329°, 14 feet; No. 2, 1½-foot cottonwood, 273°, 21 feet; No. 3, 1½-foot cottonwood, 166°, 11 feet. Elevation, 65.77.

P. R. P. 28a: On back levee of Lake Home plantation; 150 feet below bend in levee and 1,130 feet above fence running towards the river. Bench is 1,650 feet from river at a point about 1,000 feet above mouth of small bayou. It coincides with Chain Line Point E. O., survey of 1886. Elevation, 63.94.

P. R. P. 29: About 1 mile above where river strikes Hurricane Bluffs and seven-eighths mile above mouth of Old River. It is at foot of bluffs, opposite Martin and Hugh's plantation, and 80 feet from bank of Old River. Reference trees: No. 1, 3-foot cottonwood, 67°, 50 feet; No. 2, 3-foot red oak, 162°, 40 feet; No. 3, 3-foot pine, 302°, 30 feet. Elevation, 64.61.

P. R. P. 30a: (P. R. P. 30 disturbed by landslide and P. R. P. 30a substituted.) Is on top of Hurricane Bluffs, in small orchard on inside of fence in front of plantation house, 60 feet north of gate and 90 feet northwest of plantation store. Elevation, 73.78.

P. R. P. 31. On Col. Vance's plantation, at intersection of fence on west side of public road with fence on north side of stable-yard, and 3 feet east of timber supporting southeast corner of windmill tower. Elevation, 60.21.

P. R. P. 32: On plantation of T. J. Vance, in front of plantation house, and on top of levee about 420 feet above Benoit Bayou. References: No. 1, southwest corner dwelling house, 265° 40′, 212 feet; No. 2, large cottonwood, 193° 43′; No. 3, large cottonwood, 224° 45′; No. 4, large cottonwood, 281° 37′. Elevation, 61.56.

P. R. P. 33: In southwest corner of yard around cabin on estate of M. Barr, and just above Barr Ferry, about 400 feet from river opposite J. W. Jeter's plantation. Elevation, 58.79.

P. R. P. 34: Right bank; at northeast corner of cabin on E. B. Herndon's plantation, and nearly opposite line between plantations of Mrs. Carmouché and Pat. Cash. Elevation, 59.48.

P. R. P. 35: In southwest corner of yard of residence of Mrs. M. D. C. Cane, at Bossier City, opposite Shreveport. Elevation, 58.21.

## TOPOGRAPHY.

The position of river banks, lakes, sloughs, bayous, woods, fields, houses, property lines, and principal contour points has been determined over an area about 700 meters wide on each side of the river, and the larger tributaries have been traced about 3,000 meters above their entrance into the river. At intervals of about 8 kilometers permanent reference sections were established with two points on each bank marked by cement-filled vitrified pipe. Those nearest the banks were set about 50 meters back and the others about 400 meters back. These points were all located instrumentally and will serve to measure changes which may take place in the banks and sections.

Between Fulton and Shreveport monuments have been set as reference for topographical work done in 1886–'87. Table 6 gives description of location and their elevation, and plates show location.

All work was done by transit and stadia method. Azimuth generally checked on the triangulation within two minutes in a run of 8 kilometers, and elevations within 0.3 meter. Sheets were plotted in pencil to check the fieldwork as it progressed, but are now being rearranged and replotted in the office on a scale of 1:10,000.

## HYDROGRAPHY.

Sections were located by instrument about 400 meters apart and soundings spaced by time. Channel soundings between sections were spaced by time and located on sketches by estimated distance from either bank. All soundings were reduced to what they would be if the gauge at Shreveport had read 10 feet continuously while the soundings were made. This was done in the following manner: It was assumed that the rate of progress of a change of stage was uniform between two consecutive gauges. The time interval between gauges was obtained by noting the time of reversion at each gauge—*i. e.*, the beginning or end of a rise or fall. The mean of all the time intervals was taken as the interval, and the mean of all the readings at each gauge at each reverstion as the corresponding gauge reading. The ratios of corresponding gauge readings at consecutive gauges gave gauge relation. These "time intervals," "corresponding gauge readings," and "gauge relations" were determined from a number of observations with the river as near 10

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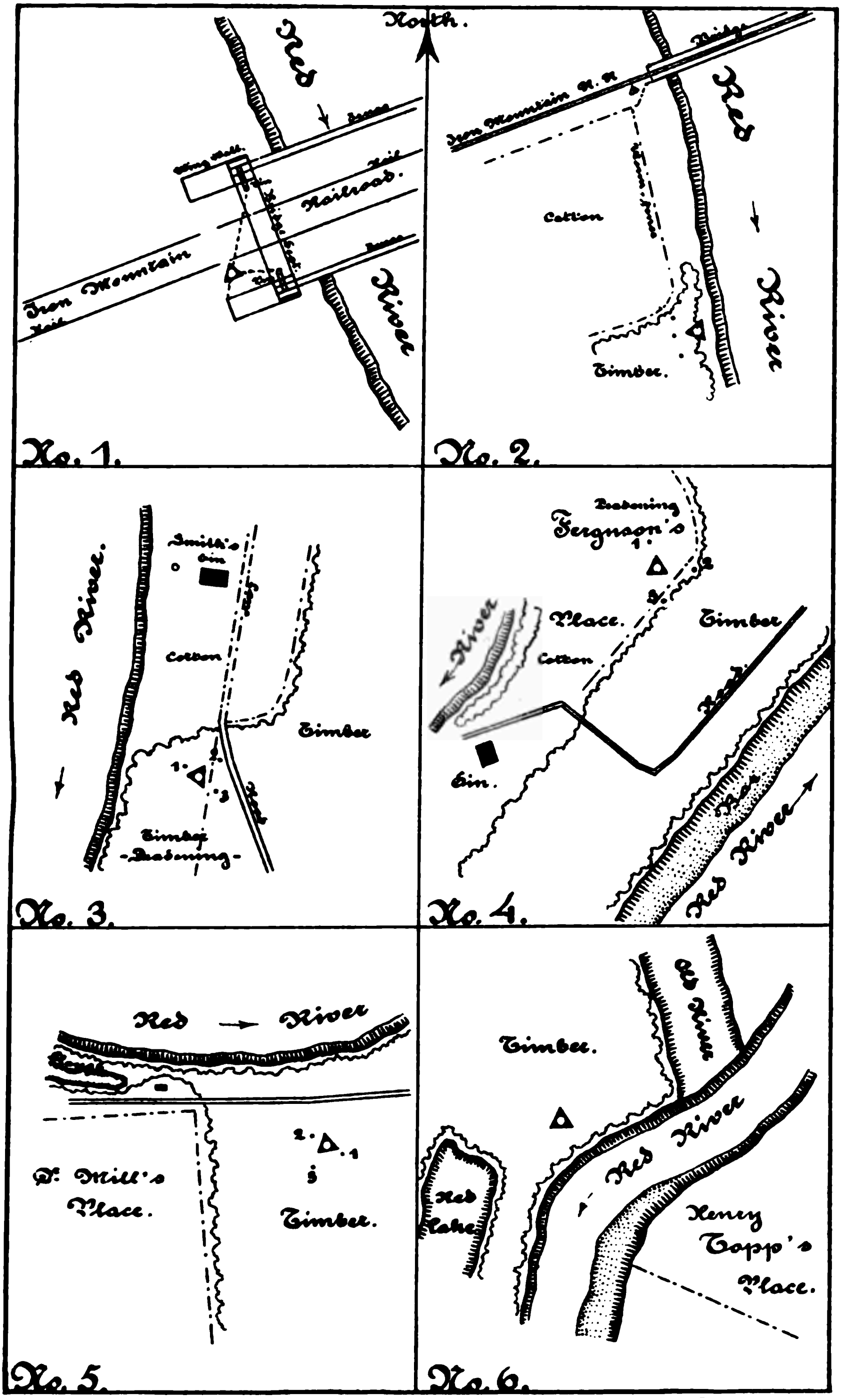

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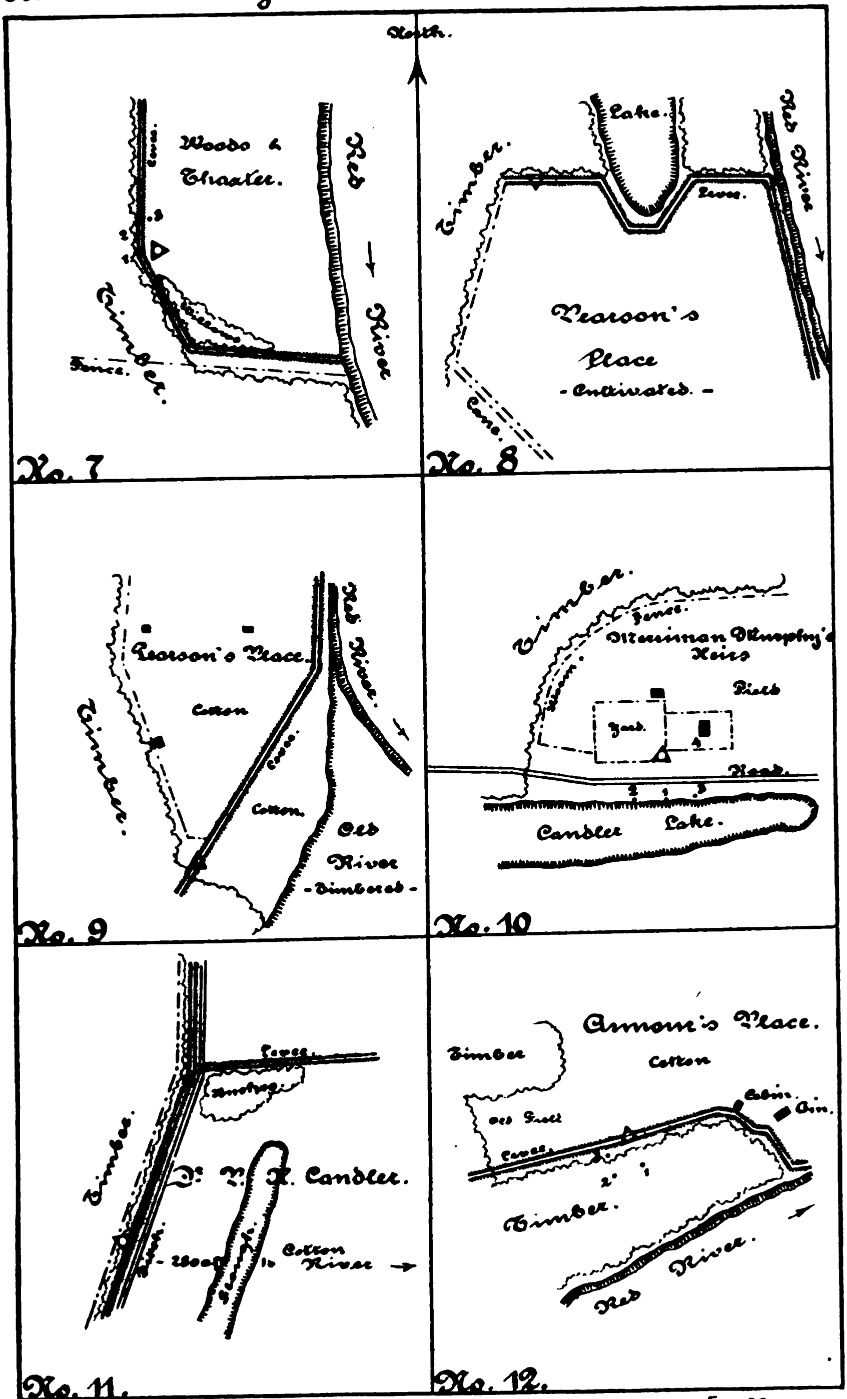

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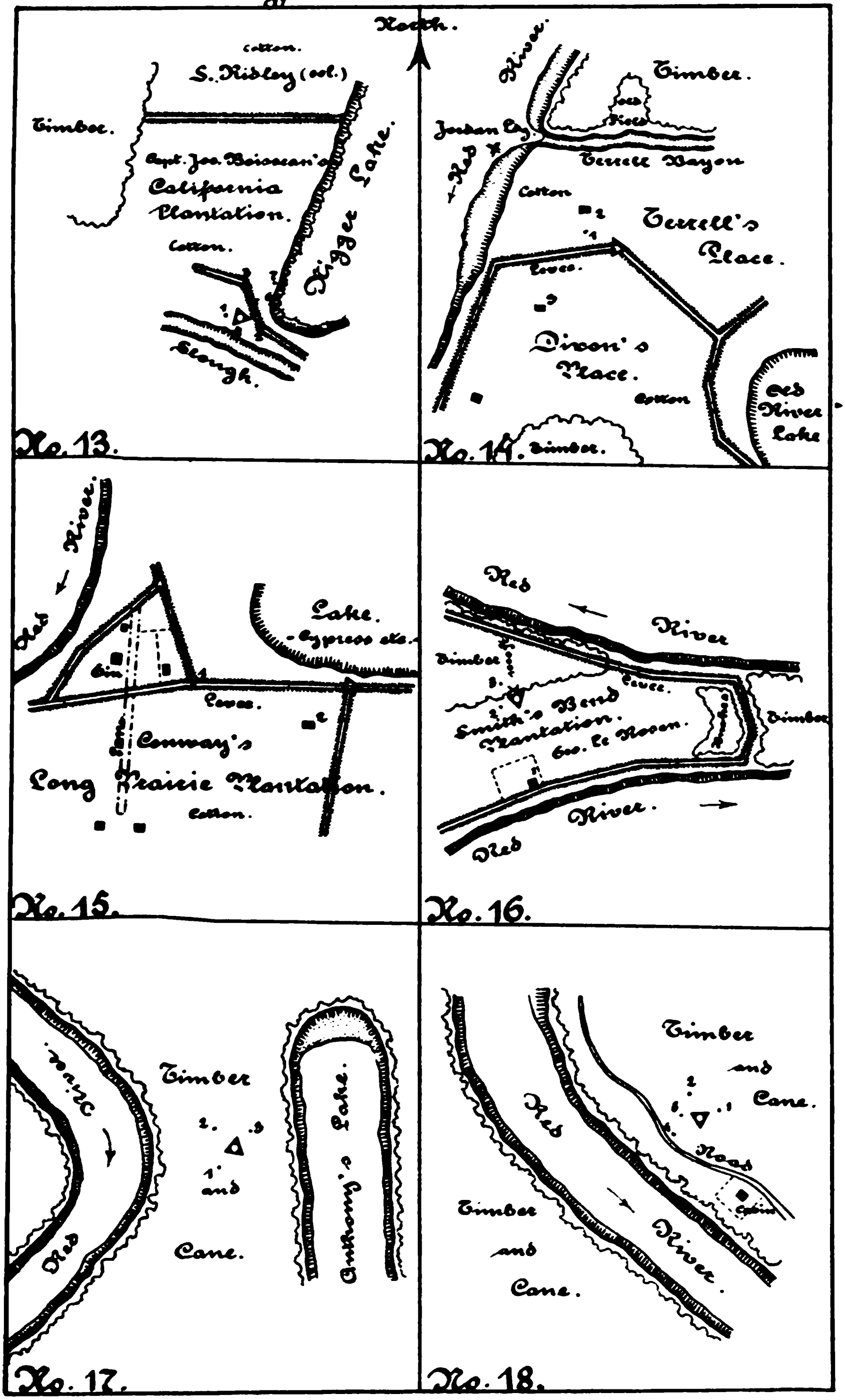

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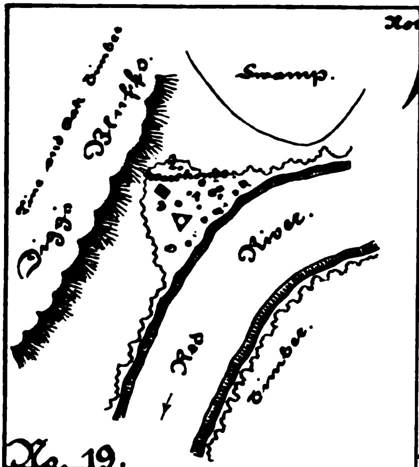

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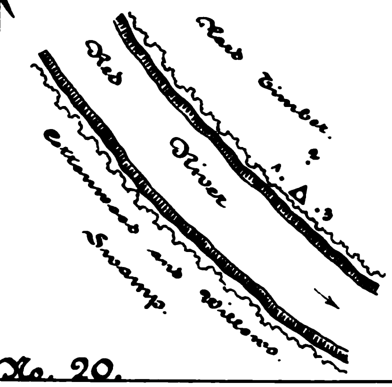

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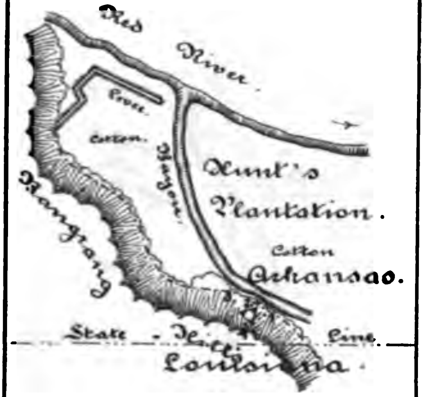

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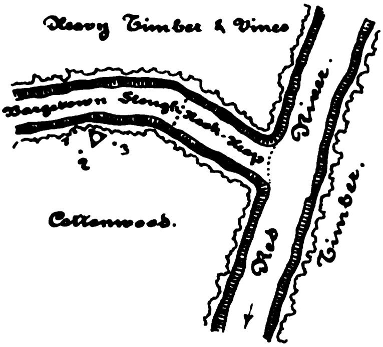

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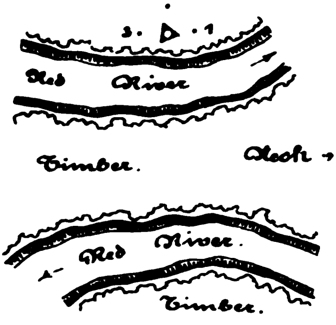

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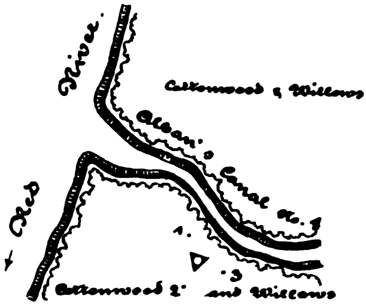

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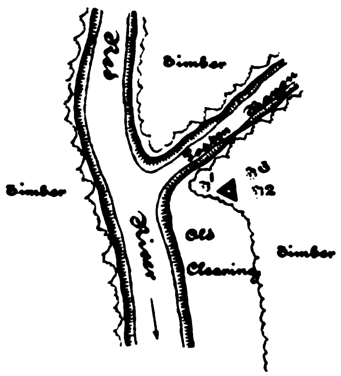

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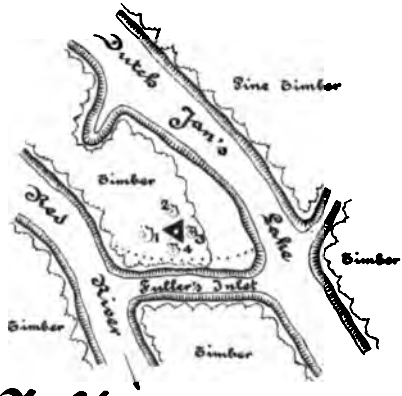

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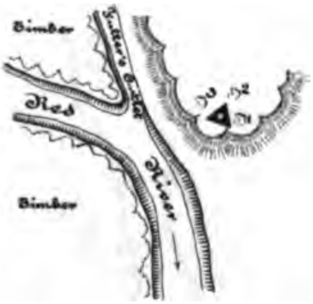

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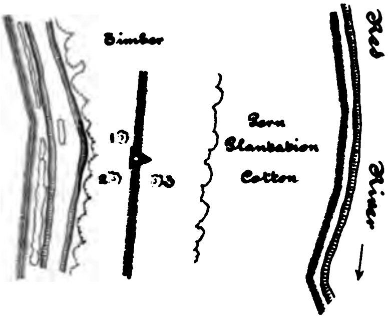

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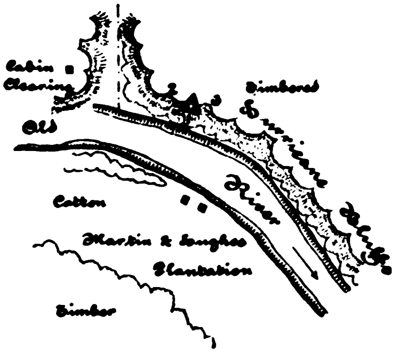

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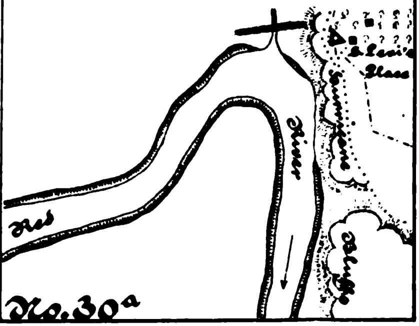

No. 30ª

Photo-Lith. by A. Hoen & Co. Baltimore, Md.

Red River Survey, - V.R.V.

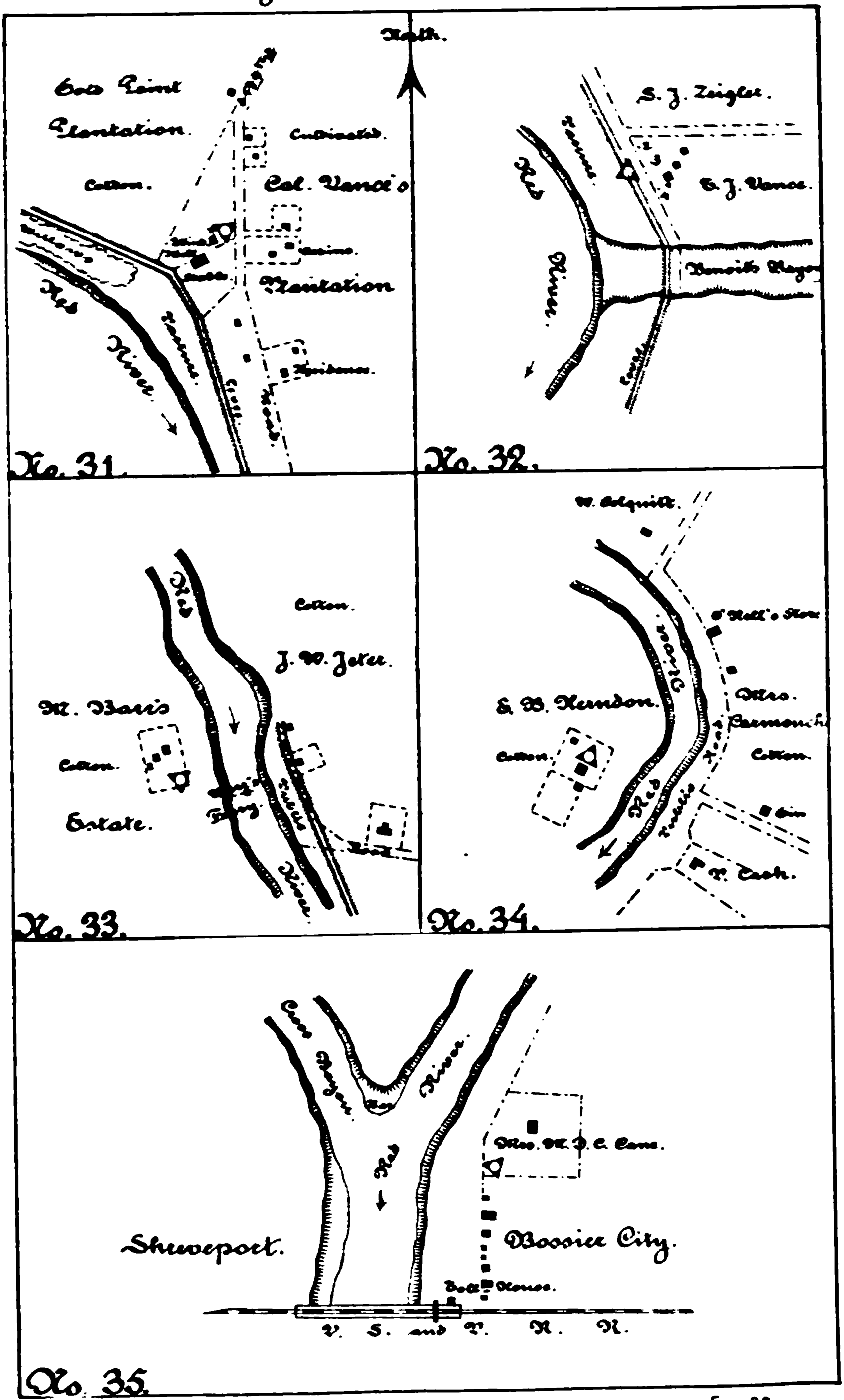

Photo-Lith. by A. Hoen & Co. Baltimore, Md.

feet at Shreveport as practicable, because, while quite true for the stage for which they are determined, they become wholly wrong for a greatly different stage. It was found that, the gauge reading at Fulton being 6.0, the gauge at Garland, 1 day 5¼ hours later, read 6.2; the gauge at Collins Bluff, 1 day and 15 hours after the Garland gauge reading, was 7.7; the gauge at Shreveport, 4 days and 4 hours later, read 10.0; the Coushatta gauge, 5 days and 15 hours later, read 6.8; the Alexandria gauge, 3 days and 0 hours later, read 4.9; giving a total of 15 days and 15¼ hours for a change of stage to travel from Fulton to Alexandria when the river is about 10 feet on the Shreveport gauge. Also, a change at Garland is 1.03 times the change at Fulton; at Collins Bluff 1.24 times the change at Garland; at Shreveport 1.29 times the change at Collins Bluff; at Coushatta 0.68 times the change at Shreveport, and at Alexandria 0.72 times the change at Coushatta.

The distance from two gauges and the time of sounding being known, correction to reduce the soundings could be found. The time interval to the sounding station being proportional to the time interval between the gauges above and below as distance to sounding station is to total distance between gauges, the time of sounding plus or minus this quantity gave time of gauge reading corresponding to the existing stage. The difference between gauge reading at that time and gauge reading corresponding to 10 feet at Shreveport multiplied by the ratio of distance of the sounding to distance between gauges multiplied by the gauge relation gave correction.

Below Alexandria the relation of stage is so obscured that even this method, which was a compromise between taking accurate account of the change of slope with a given change of stage and of assuming the slope to be the same for all stages, had to be discarded. The stage at Shreveport is only one factor in the stage in the lower river, and is not the most important one either. There were no gauges from which it could be ascertained by how much the stage at which the soundings were taken differed from a "10-foot stage," there or elsewhere. In other words, although the elevation of the water surface at each sounding section was ascertained by actual instrumental measurement at the time of the sounding, and although the elevation of the bottom of the river was actually ascertained within the error due to measurement, and is plotted on the profiles and cross sections correctly, yet because the elevation of the water surface at a "10-foot stage" could not be ascertained, it is impossible to determine how much correction to apply to the soundings. As the water-surface elevation and the soundings at each place are corrected by the same amount before writing them on the map, the elevation of the bottom may be exactly calculated; that is, the elevation at that time, for no system can take into account changes due to scour and fill. I have seen a section across the Mississippi River sounded when a gauge near by read 28 feet above zero, and the deepest water found was only 20 feet; that same section, sounded four months later, showed 20 feet with the gauge reading zero. No such violent changes as this take place on Red River, but the elevation of the bottom does vary with the stage, and this is another element of uncertainty in correcting for stage.

The amount of sediment floating in the water has been measured from time to time, and the results are given in Table 7. The quantity seems to be independent of the stage, but follows closely the rate of rise and fall of the river.

Table 8 gives the elevations of high water at all times and places of which a reasonably reliable record could be found. The high-water slopes of 1890 and 1892 are given in the profile.

Table 9 gives the discharge and Table 10 the elevations of gauge zeros. Discharges have all been derived graphically. The river cross section being plotted to horizontal scale 1:1000 and vertical scale 1:100, the observed velocities were plotted immediately below on the sheet to the same horizontal scale for location and to scale 1:10 for the rate. As nearly regular curve as could be drawn freehand was passed through the points representing the velocities and the shore points. The area of section and velocity curve was then divided into strips of like width and these areas taken off by planimeter. The area of any strip of the velocity curve divided by its width gave the average velocity in the corresponding strip of the cross section, and the product of this average velocity and the area, when corrected by a coefficient to reduce to mean velocity, gave the discharge in the strip. The term "average velocity" is used because no direct measurement of the mean velocities was attempted. Usually the mid-depth velocity was measured by a Price current meter and the computed discharge therefrom reduced 4 per cent. Sometimes surface floats and sometimes rod floats were used and the discharge corrected by a percentage. When the strips are taken so that the depths of the cross sections differ but little among themselves, this method of computation gives results as exact as is justified by the field measurements; not that all errors combined amount to much, as is shown by the close agreement when discharge was taken above an outlet or tributary and in and below it. The sum or difference of the two being in the nature of things equal to the third a test of the correctness is afforded, for it would be scarcely possible that errors of measurement should continually tend to balance. To test the method, as against the assumption that an observed mid-depth velocity is the mean of the mid-depth velocities equidistances to each side, the discharge near Shreveport, measured in February, 1891, was computed by both methods. The discharge of Red River above Twelve Mile Bayou, of that bayou, and of Cross Bayou, and of Red River below the junction of river and bayous, was gauged at a bank-full stage.

Another method of computing the discharge has lately been tried and probably will prove very satisfactory. The cross section and velocity curve having been plotted, the product of the velocity at any point by the depth of the cross section at that point, the two being measured on the diagram, is plotted as an ordinate to the width of the cross section at the same position at which the factors obtained. If points be thus plotted, wherever there is a considerable change in depth or mid-depth velocity, the curve drawn through them is a graphical representation of the discharge, and the area taken off by the planimeter is the measure thereof. This method gives weight to each velocity according to the number of particles in its vertical plane.

The following table shows comparison of results by the three methods of computation with the same data, and are designated I, II, III, corresponding to their order in the foregoing explanation. The methods are illustrated by the diagram.

*Results of discharge measurements, Red River and tributaries near Shreveport, La., February, 1891.*

| Date. | Water surface, Cairo datum. | Method of computation. | Cubic meters per second. | | | | | Difference. | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Cross Bayou. | Twelve Mile Bayou. | Upper Red River. | Total. | Lower Red River. | Cubic meters. | Per cent. |
| 1891. | *Meters.* | | | | | | | | |
| Feb. 19 | 56.43 | I | ........ | ........ | 359 | ........ | ........ | ........ | ........ |
| | | II | ........ | ........ | 392 | ........ | ........ | ........ | ........ |
| | | III | ........ | ........ | 381 | ........ | ........ | ........ | ........ |
| Feb. 21 | 56.48 | I | ........ | 523 | 306 | ........ | ........ | ........ | ........ |
| | | II | ........ | 668 | 322 | ........ | ........ | ........ | ........ |
| | | III | ........ | 562 | 313 | ........ | ........ | ........ | ........ |
| Feb. 23 | 56.31 | I | 694 | *496 | *292 | 1,482 | 1,424 | + 58 | 4.1 |
| | | II | 642 | *608 | *312 | 1,562 | 1,452 | +110 | 7.6 |
| | | III | 731 | *535 | *302 | 1,568 | 1,458 | +110 | 7.6 |
| Feb. 25 | 56.04 | I | *610 | 454 | 269 | 1,333 | *1,334 | − 1 | 0.0 |
| | | II | *547 | 417 | 296 | 1,260 | *1,402 | −142 | 10.1 |
| | | III | *671 | 496 | 285 | 1,452 | *1,375 | + 77 | 5.6 |
| Feb. 26 | 55.93 | I | 576 | *452 | *270 | 1,298 | 1,298 | 0 | 0.0 |
| | | II | 516 | *432 | *306 | 1,254 | 1,385 | −131 | 9.5 |
| | | III | 609 | *490 | *285 | 1,384 | 1,342 | + 42 | 3.1 |
| Feb. 27 | 55.82 | I | *541 | 450 | *272 | 1,263 | *1,286 | − 23 | 1.8 |
| | | II | *514 | 448 | *316 | 1,278 | *1,346 | − 68 | 5.1 |
| | | III | *573 | 485 | *286 | 1,344 | *1,318 | + 26 | 2.0 |
| Feb. 28 | 55.69 | I | 500 | *448 | 273 | 1,221 | 1,271 | − 50 | 3.9 |
| | | II | 510 | *433 | 325 | 1,268 | 1,306 | − 38 | 2.9 |
| | | III | 530 | *479 | 287 | 1,296 | 1,291 | + 5 | 0.4 |

* Interpolated.

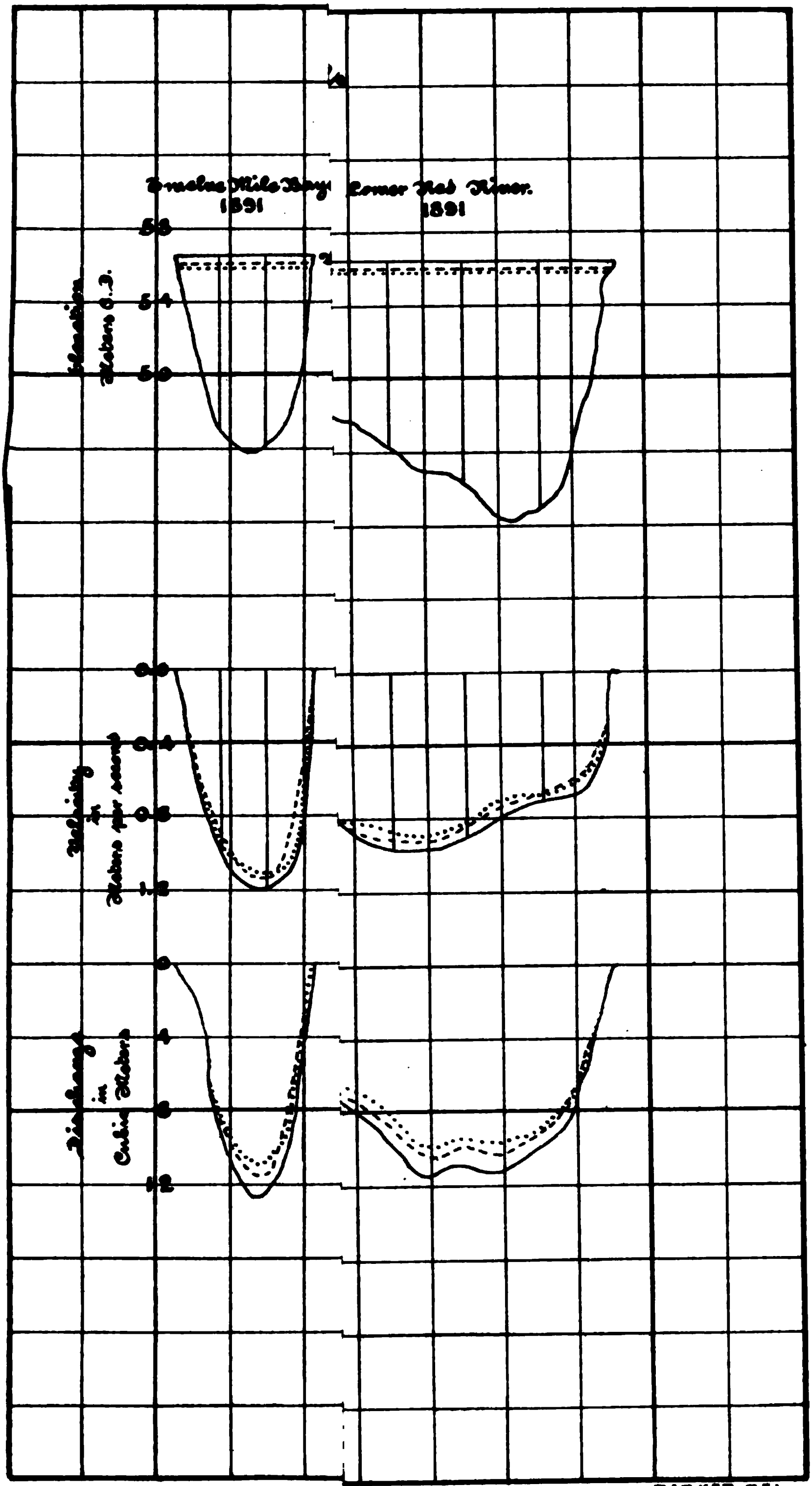

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TABLE 7.—*Sediment in Red River, Fulton, Ark., to head of Atchafalaya River, Louisiana.*

[Observers: T. C. Thomas, W. H. Polk.]

| Locality. | Date. | Elevation of water surface, Cairo datum. | Ratio of weight of sediment to weight of water. | | |
|---|---|---|---|---|---|
| | | | Surface. | Mid depth. | Bottom. |
| | | *Meters.* | | | |
| Jett Island | Jan. 4, 1893 | 79.26 | 0.0005 | 0.0007 | 0.0007 |
| California Place (upper end) | Jan. 19, 1893 | 70.79 | 0.0002 | 0.0001 | 0.0002 |
| Above mouth of Sulphur River | Jan. 25, 1893 | 69.43 | 0.0001 | 0.0005 | 0.0001 |
| Above mouth Twelve Mile Bayou | Feb. 21, 1891 | .......... | 0.0003 | 0.0005 | 0.0004 |
| Shreveport, La | Feb. 23, 1891 | 56.30 | 0.0001 | 0.0003 | 0.0008 |
| Do | Mar. 3, 1891 | 55.49 | 0.0001 | 0.0003 | 0.0002 |
| Do | Feb. 11, 1893 | 52.72 | 0.0001 | 0.0002 | 0.0003 |
| Above head of Tones Bayou | Apr. 21, 1891 | 52.85 | 0.0002 | 0.0004 | .......... |
| Below head of Tones Bayou | Apr. 24, 1891 | 53.38 | 0.0001 | 0.0002 | 0.0002 |
| At head of Tones Bayou | Apr. 28, 1891 | 53.69 | 0.0005 | 0.0014 | 0.0015 |
| Above mouth of Loggy Bayou | May 2, 1891 | 44.83 | 0.0005 | 0.0012 | 0.0011 |
| Below mouth of Loggy Bayou | May 6, 1891 | 45.15 | 0.0007 | 0.0008 | 0.0009 |
| Above mouth of Bayou Wincey | May 14, 1891 | 40.39 | 0.0005 | 0.0007 | 0.0008 |
| Do | May 22, 1891 | 39.87 | 0.0003 | 0.0005 | 0.0007 |
| Below mouth of Bayou Wincey | May 19, 1891 | 40.21 | 0.0004 | 0.0007 | 0.0001 |
| Above head of Cane River | May 28, 1891 | 32.96 | 0.0004 | 0.0006 | 0.0007 |
| Below head of Cane River | May 30, 1891 | 32.63 | 0.0003 | 0.0004 | 0.0006 |
| Do | June 5, 1891 | 31.83 | 0.0003 | 0.0004 | 0.0004 |
| Do | Feb. 28, 1893 | 32.61 | 0.0007 | 0.0007 | 0.0008 |
| Above mouth of Cane River | June 11, 1891 | 25.39 | 0.0004 | 0.0004 | 0.0004 |
| Above Alexandria, La | June 20, 1891 | 22.42 | 0.0019 | 0.0020 | 0.0021 |
| Do | July 31, 1891 | 20.63 | 0.0002 | 0.0002 | 0.0001 |
| Do | Aug. 29, 1891 | 20.88 | 0.0004 | 0.0004 | 0.0004 |
| Alexandria, La | June 17, 1891 | 21.98 | 0.0008 | 0.0006 | 0.0007 |
| Do | June 25, 1891 | 22.92 | 0.0007 | 0.0008 | 0.0009 |
| Do | July 1, 1891 | 23.09 | 0.0005 | 0.0006 | 0.0005 |
| Do | July 8, 1891 | 23.47 | 0.0007 | 0.0007 | 0.0008 |
| Do | July 14, 1891 | 22.42 | 0.0004 | 0.0007 | 0.0006 |
| Do | Aug. 8, 1891 | 20.47 | 0.0002 | 0.0003 | 0.0004 |
| Do | Aug. 15, 1891 | 21.24 | 0.0007 | .......... | 0.0007 |
| Do | Aug. 22, 1891 | 21.43 | 0.0011 | 0.0011 | 0.0009 |
| Do | Mar. 7, 1893 | 24.01 | 0.0002 | 0.0005 | 0.0003 |
| Saline Point (stone line 64) | Nov. 21, 1891 | 12.21 | 0.00016 | 0.00008 | 0.00016 |
| Do | Nov. 25, 1891 | 13.80 | 0.00008 | 0.00016 | 0.00016 |
| Lake Latania (stone line 66) | Dec. 2, 1891 | 11.60 | 0.00008 | 0.00016 | 0.00008 |
| Do | Dec. 9, 1891 | 11.91 | 0.00008 | 0.00013 | 0.00015 |
| Above mouth of Black River | Dec. 21, 1891 | 10.59 | 0.00008 | 0.00008 | 0.00017 |
| Do | Mar. 14, 1893 | 19.06 | 0.0003 | 0.0004 | 0.0007 |
| Above Seven Mile Bayou | Dec. 29, 1891 | 12.60 | 0.0008 | 0.0010 | 0.0014 |
| △ 457, above Bayou Cocodrie | Jan. 6, 1892 | 18.50 | 0.0002 | 0.0002 | 0.0004 |

NOTE—"Above" or "below" means from 0.5 to 1.0 kilometer.

*Tributaries and outlets.*

[NOTE.—Samples obtained from 0.5 to 1.0 kilometer from Red River.]

| Locality. | Date. | Elevation of water surface, Cairo datum. | Ratio of weight of sediment to weight of water. | | |
|---|---|---|---|---|---|
| | | | Surface. | Mid depth. | Bottom. |
| | | *Meters.* | | | |
| Sulphur River | Jan. 25, 1893 | 69.43 | 0.0001 | 0.0001 | 0.0001 |
| Cross Bayou | Mar. 2, 1891 | .......... | 0.0001 | 0.00007 | 0.0001 |
| Tones Bayou | Apr. 25, 1891 | 53.45 | 0.0002 | 0.0002 | 0.0002 |
| Loggy Bayou | May 2, 1891 | 44.83 | 0.00001 | 0.00004 | 0.00003 |
| Do | Feb. 21, 1893 | 43.70 | 0.00005 | 0.0001 | 0.0001 |
| Bayou Wincey | May 19, 1891 | 40.21 | 0.0002 | 0.00004 | 0.0002 |
| Do | May 23, 1891 | 39.75 | 0.0002 | 0.0002 | 0.0002 |
| Do | Feb. 24, 1893 | 38.32 | 0.0001 | 0.0001 | 0.0001 |
| Head of Cane River | June 2, 1891 | 32.18 | 0.0002 | 0.0003 | 0.0005 |
| Mouth of Cane River | June 8, 1891 | 25.61 | 0.00006 | 0.00007 | 0.00009 |
| Bayou Rapides | June 20, 1891 | 22.42 | 0.00007 | 0.00004 | 0.00006 |
| Black River | July 26, 1891 | 13.59 | 0.00009 | 0.00010 | 0.00006 |
| Do | Dec. 21, 1891 | 10.59 | 0.00008 | 0.00016 | 0.00009 |
| Do | Mar. 14, 1893 | 19.06 | 0.00001 | 0.00001 | 0.00007 |

TABLE 8.—*High-water marks on Red River in Arkansas and Louisiana.*

### HIGH-WATER MARKS OF 1849.

| Locality. | Distance from Fulton, Ark. | Elevation, Cairo datum. | Remarks. |
|---|---|---|---|
| | *Kilometers.* | *Meters.* | |
| Cairo Place, La | 263.7 | 62.45 | Authentic. |
| Shreveport, La | 303.2 | 60.00 | Do. |
| Alexandria, La | 640.0 | 30.44 | Uncertain. |
| Once More Landing, La | 683.0 | 26.95 | Authentic. |

### HIGH-WATER MARKS OF 1866.

| | | | |
|---|---|---|---|
| Fulton, Ark | 0.0 | 85.40 | |
| Spring Bank, Ark | 174.2 | 71.84 | |
| Kouns Canal, La | 209.2 | 70.14 | |
| Coushatta Bluffs, La | 230.6 | 67.62 | Authentic. |
| Carolina Bluffs, La | 248.9 | 63.96 | Do. |
| Cairo Place, La | 263.7 | 61.94 | Do. |
| Opposite Swan Lake, La | 294.3 | 60.97 | Do. |
| Shreveport, La | 303.2 | 60.09 | Do. |
| Alexandria, La | 640.0 | 30.54 | Do. |
| Once More Landing, La | 683.0 | 26.94 | Do. |

### HIGH-WATER MARKS OF 1874.

| | | | |
|---|---|---|---|
| Blanton Bluffs, Ark | 188.9 | 70.17 | |
| Posten Bayou, La | 217.3 | 68.41 | |
| McQuilla Slough, La | 219.5 | 67.92 | |
| Coushatta Bluffs, La | 229.6 | 67.01 | |
| Carolina Bluffs, La | 248.9 | 63.23 | Uncertain elevation. |
| Hurricane Bluffs, La | 260.0 | 62.27 | |
| Cairo Place, La | 263.7 | 61.97 | Authentic mark; uncertain elevation. |
| Buck Hall Place, La | 279.3 | 61.51 | |
| Shady Grove Place, La | 284.1 | 61.21 | |
| Dillard Place, La | 299.9 | 59.26 | |
| Twelve-mile Bayou, La | 301.5 | 58.39 | |
| Shreveport, La | 303.2 | 58.33 | Reading of gauge Apr. 29–May 1. |
| Alexandria, La | 640.0 | 30.28 | Reading of gauge May 8–10. |
| Chauffepied Place, La | 698.6 | 25.32 | |
| Barbin Landing, La | 719.6 | 23.34 | Authentic. |
| Red River Landing, La | 829.9 | 21.59 | Reading of gauge Apr. 16. |

### HIGH-WATER MARKS OF 1879.

| | | | |
|---|---|---|---|
| Blanton Bluffs, Ark | 188.9 | 70.01 | May 2. |
| McQuilla Slough, La | 219.5 | 67.73 | |
| Elmer Slough, La | 226.1 | 66.63 | |
| Coushatta Bluffs, La | 229.6 | 66.75 | |
| Dooley Bayou, La | 230.9 | 66.54 | |
| East Egypt Place, La | 232.5 | 66.26 | |
| Carolina Bluffs, La | 248.9 | 62.97 | |
| Hurricane Bluffs, La | 260.0 | 62.55 | |
| Cairo Place, La | 263.7 | 61.34 | |
| Williams Bayou, La | 279.4 | 60.61 | |
| Shreveport, La | 303.2 | 56.83 | Reading of gauge, May 16, 17. |
| Tones Bayou, La | 332.6 | 54.57 | Reading of gauge, May 16–18. |
| Alexandria, La | 640.0 | 25.50 | Reading of gauge, May 26. |
| Red River Landing, La | 829.9 | 12.88 | Reading of gauge, June 16–18. |

### HIGH-WATER MARKS OF 1882.

| | | | |
|---|---|---|---|
| Shreveport, La | 303.2 | 58.73 | Reading of gauge, Feb. 21. |
| Elder Grove, La | 420.4 | 48.78 | Authentic. |
| Dan Giddens Place, La | 455.0 | 45.09 | Do. |
| Alexandria, La | 640.0 | 30.52 | Authentic. Mar. 17–19. |
| Maj. Watts Place, La | 642.2 | 30.47 | |
| Chas. Spriggins Place, La | 644.0 | 30.46 | |
| Harris Place, La | 648.2 | 30.29 | |
| Ashton Landing, La | 649.0 | 30.02 | |

TABLE 8.—*High-water marks on Red River in Arkansas and Louisiana*—Continued.

### HIGH-WATER MARKS OF 1882—Continued.

| Locality. | Distance from Fulton, Ark. | Elevation, Cairo datum. | Remarks. |
|---|---|---|---|
| | *Kilometers.* | *Meters.* | |
| Peart Woodyard, La | 653.5 | 29.80 | |
| Near Grand Bend Landing, La | 654.9 | 29.65 | |
| Cut-off Bayou, La | 656.2 | 29.47 | |
| Below Cut-off Bayou, La | 657.0 | 29.19 | |
| Bayou Latanier, La | 660.9 | 29.12 | |
| Above Beaver Dam, La | 664.5 | 28.46 | |
| Beaver Dam, La | 666.7 | 28.18 | |
| Stafford Place, La | 670.8 | 27.94 | |
| Below F. L. Peart Place, La | 673.1 | 27.66 | |
| Joffrion Place, La | 674.4 | 27.57 | |
| Once More Landing, La | 683.0 | 26.97 | Authentic. |
| Echo Landing, La | 683.9 | 26.70 | |
| Below Echo Landing, La | 685.4 | 26.52 | |
| S. Cox Place, La | 680.7 | 26.52 | |
| Below S. Cox Place, La | 687.7 | 26.34 | |
| Egg Bend, La | 688.5 | 26.22 | |
| Bringgold Place, La | 691.2 | 26.02 | |
| Bayou Wiggins, La | 693.3 | 25.70 | |
| Calhoun Place, La | 694.1 | 25.61 | |
| Chauffepied Place, La | 698.6 | 25.38 | |
| Do | 700.2 | 25.21 | |
| Near David Ferry, La | 702.0 | 25.15 | |
| David Ferry, La | 702.5 | 25.08 | Do. |
| Barbin Landing, La | 719.6 | 24.21 | Do. |
| Little Larto Bayou, La | 763.6 | 24.32 | Do. |
| Above Black River, La | 772.2 | 23.91 | Do. |
| Mouth of Black River, La | 772.7 | 23.48 | Do. |
| Bayou Cocodrie, La | 792.2 | 23.42 | Do. |
| Barbre Landing, La | 817.3 | 22.52 | Reading of gauge, Mar. 27. |
| Red River Landing, La | 829.9 | 22.04 | Do. |

### HIGH-WATER MARKS OF 1884.

| | | | |
|---|---|---|---|
| Shreveport, La | 303.2 | 59.18 | Authentic. |
| Bayou Pierre, La | 306.2 | 58.84 | |
| Crowder Place, La | 317.8 | 57.44 | Do. |
| Tones Bayou, La | 332.6 | 55.58 | |
| Lotus Landing, La | 337.5 | 55.11 | |
| Pascagoula Bayou, La | 350.6<br>*353.1 | 53.81 | |
| Elder Grove Place, La | †424.9<br>420.4 | 49.43 | Do. |
| Dan Giddens Place, La | 455.0 | 45.68 | |
| O. K. Landing, La | 546.8 | 37.17 | |
| Alexandria, La | 640.0 | 30.39 | Reading of gauge May 30–31. |
| Once More Landing, La | 683.0 | 26.97 | Authentic. |
| Bayou Cocodrie, La | 792.2 | 22.93 | Do. |
| Barbre Landing, La | 817.3 | 22.11 | Reading of gauge Mar. 30, 31. |
| Red River Landing, La | 829.9 | 22.04 | Reading of gauge Mar. 29–31. |

### HIGH-WATER MARKS OF 1885.

| | | | |
|---|---|---|---|
| Lake Scott Slough, Ark | 10.1 | 84.13 | |
| Smith Bend, Ark | 13.2 | 83.43 | |
| Hervey Place, Ark | 29.6 | 82.33 | |
| Mills Place, Ark | 32.2 | 81.99 | |
| Williams Place, Ark | 37.2 | 81.54 | |
| Batt Place, Ark | 39.0 | 81.44 | |
| Bois D'Arc Bayou, Ark | 40.6 | 81.35 | |
| Dooley Ferry, Ark | 41.5 | 81.17 | |
| Jett Island, Ark | 45.4 | 80.74 | |
| Red Lake, Ark | 48.9 | 80.19 | |
| Martin Place, Ark | 52.9 | 79.91 | |
| Finley Place, Ark | 60.0 | 79.48 | |
| Person Place, Ark | 75.9 | 78.06 | |
| Murphy Place, Ark | 86.2 | 77.36 | |
| Garland, Ark | 93.2 | 76.75 | Uncertain. |
| Russell Place, Ark | 96.0 | 76.38 | |

*Measured through Old River at Waterloo Cutoff (1889).

†Measured through Old River at Young Point Cutoff (1890).

TABLE 8.—*High-water marks on Red River in Arkansas and Louisiana*—Continued.

HIGH-WATER MARKS OF 1885—Continued.

| Locality. | Distance from Fulton, Ark. | Elevations, Cairo datum. | Remarks. |
|---|---|---|---|
| | *Kilometers.* | *Meters.* | |
| Thatcher Place, Ark | 98.7 | 76.04 | |
| Crowell Place, Ark | 101.7 | 75.74 | |
| Dr. Caudler Place, Ark | 103.1 | 75.74 | |
| Dixon Place, Ark | 112.3 | 74.92 | |
| Bonanza Place, Ark | 122.0 | 74.10 | |
| California Place, Ark | 132.6 | 73.46 | |
| Cedar Point Place, Ark | 141.0 | 72.88 | |
| Jacob Place, Ark | 161.2 | 71.72 | |
| Blanton Place, Ark | 178.3 | 70.93 | |
| O'Rouks Slough, La | 197.8 | 69.78 | |
| Red Bayou, La | 220.0 | 68.14 | |
| Elmer Slough, La | 226.1 | 67.44 | |
| Dooley Bayou, La | 230.9 | 67.18 | |
| Lake Place, La | 264.4 | 62.73 | |
| Shady Grove Place, La | 284.7 | 61.91 | |
| Shreveport, La | 303.2 | 58.45 | Reading of gauge May 11, 12. |
| Alexandria, La | 640.0 | 30.10 | Reading of gauge Jan. 25. |
| Barbre Landing, La | 817.3 | 19.99 | Reading of gauge Feb. 1–6. |
| Red River Landing, La | 829.9 | 20.06 | Reading of gauge Feb. 5–6. |

HIGH-WATER MARKS OF 1890.

| | | | |
|---|---|---|---|
| Fulton, Ark | 0.0 | 84.98 | Authentic, May 3. |
| Kye Smith Landing, Ark | 17.1 | 83.54 | Authentic. |
| Dooley Ferry, Ark | 41.5 | 81.54 | Do. |
| Haynes Place, Ark | 87.7 | 77.51 | Do. |
| Garland, Ark | 93.2 | 76.69 | Reading of gauge, Apr. 30. |
| Sentell Place, Ark | 112.9 | 75.13 | Authentic. |
| Booker Landing, Ark | 123.9 | 74.10 | Do. |
| Cedar Point Place, Ark | 137.7 | 73.25 | Do. |
| Lee Store, Ark | 145.9 | 72.85 | Do. |
| Collins Bluff, Ark | 173.8 | 72.13 | Do. |
| Missionary Place, La | 192.0 | 70.84 | Do. |
| Bargetown Slough, La | 195.9 | 70.76 | |
| Kotuns Canal, La | 209.2 | 70.21 | |
| Posten Bayou, La | 217.2 | 69.10 | |
| Elmer Slough, La | 226.1 | 68.13 | |
| Dooley Bayou, La | 230.9 | 67.60 | |
| Sterling Bayou, La | 252.3 | 65.29 | |
| Above Cottonwood Bayou, La | 253.8 | 64.72 | |
| Shreveport, La | 303.2 | 59.73 | Reading of gauge, May 3. |
| Crowder Place, La | 317.8 | 57.96 | Authentic. |
| Curtis Place, La | 319.2 | 58.08 | Do. |
| Lotus Landing, La | 337.5 | 55.80 | Do. |
| Mercer Place, La | 342.0 | 55.18 | |
| Hodges Place, La | 347.6 | 54.33 | |
| White House Place, La | 351.9 | 53.73 | |
| Pascagoula Store, La | 355.2 | 53.40 | |
| Caspiana Place, La | 367.9 | 52.64 | Do. |
| Whitehall Landing, La | 373.0 | 52.29 | Do. |
| Cross Keys Place, La | 382.7 | 51.91 | |
| Howard P. O., La | 393.9 | 51.47 | Do. |
| Bayou La Chute, La | 401.3 | 50.67 | |
| Loggy Bayou, La | 405.2 | 50.60 | Do. |
| Williams P. O., La | 408.3 | 50.46 | |
| East Point, La | 410.4 | 50.20 | |
| Elder Grove Place, La | 420.4 | 49.78 | Do. |
| Pecan Point Place, La | 429.1 | 48.92 | Do. |
| Colonel Sanford Place, La | 435.2 | 48.47 | |
| Glen Martin Place, La | 443.3 | 47.48 | Do. |
| Coushatta, La | 447.8 | 47.07 | Authentic, May 15–16. |
| Dan Giddens Place, La | 455.0 | 46.01 | Authentic. |
| Kenilworth Place, La | 463.2 | 45.36 | |
| Lake End Place, La | 471.1 | 44.43 | |
| Red Plains Landing, La | 473.5 | 44.38 | Do. |
| Camp Rowdy Landing, La | 493.1 | 42.64 | |
| J. C. Henry Place, La | 497.8 | 42.01 | |
| Le Vassar Place, La | 501.5 | 41.82 | |
| Mouth of Bayou Pierre, La | 510.8 | 40.83 | |
| Willow P. O., La | 516.9 | 40.36 | Do. |
| Tiger Island, La | 526.4 | 39.48 | |
| Hecla Landing, La | 532.0 | 38.91 | |
| St. Maurice, La | 537.6 | 38.70 | |

TABLE 8.—*High-water marks on Red River in Arkansas and Louisiana*—Continued.

HIGH-WATER MARKS OF 1890—Continued.

| Locality. | Distance from Fulton, Ark. | Elevations, Cairo datum. | Remarks. |
|---|---|---|---|
| | *Kilometers.* | *Meters.* | |
| Shire Landing, La | 542.3 | 38.31 | |
| O. K. Landing, La | 546.8 | 37.59 | Authentic. |
| Above Favrison Landing, La | 548.6 | 37.68 | Uncertain. |
| High Die Place, La | 554.3 | 37.13 | Authentic. |
| Montgomery, La | 556.7 | 36.68 | Do. |
| Durand Landing, La | 561.5 | 36.45 | Do. |
| Buxton Landing, La | 567.6 | 36.08 | Do. |
| Redemption Landing, La | 571.5 | 35.76 | |
| Below St. Andre Bluffs, La | 575.2 | 35.40 | Do. |
| McMills Place, La | 579.7 | 35.33 | Do. |
| Colfax, La | 585.8 | 34.92 | Do. |
| McManus Place, La | 591.4 | 34.40 | |
| Kateland Place, La | 597.7 | 33.91 | Do. |
| Old Corynne Landing, La | 601.9 | 33.86 | |
| Boyce, La | 610.3 | 32.72 | Do. |
| Below Bayou Darro, La | 615.4 | 32.41 | |
| Rapides P. O., La | 619.9 | 32.23 | |
| Old Waters Place, La | 626.5 | 31.76 | |
| Seip Landing, La | 631.8 | 31.46 | |
| Alexandria, La. (Falls) | 638.6 | 31.10 | Do. |
| Alexandria, La | 640.0 | 30.88 | Reading of gauge, May 19. |
| Grand Bend, La | 653.2 | 29.90 | |
| Peart Place, La | 656.4 | 29.77 | |
| Rodgers Landing, La | 658.8 | 29.40 | |
| Wilson Place, La | 662.0 | 28.67 | |
| Beaver Dam, La | 666.7 | 28.90 | Uncertain. |
| Stonewall Place, La | 667.5 | 28.40 | |
| Casa Landing, La | 672.2 | 28.35 | Authentic. |
| New Poland, La | 676.2 | 27.87 | Do. |
| Once More Landing, La | 683.0 | 27.30 | Do. |
| Echo Landing, La | 683.9 | 27.15 | |
| Egg Bend, La | 689.4 | 26.83 | Do. |
| Lachenays Place, La | 692.5 | 26.35 | |
| Cassandria, La | 697.7 | 25.58 | |
| Burlin Place, La | 706.2 | 25.17 | |
| Normand Landing, La | 715.1 | 24.30 | |
| Barbin Landing, La | 719.6 | 23.90 | Do. |
| Juneau Place, La | 726.9 | 23.70 | |
| Murry Landing, La | 748.2 | 24.21 | Uncertain. |
| Little Larto Landing, La | 763.6 | 23.63 | |
| Above Black River, La | 772.2 | 23.46 | |
| Walters Landing, La | 773.6 | 23.36 | |
| Bayou Cocodrie, La | 792.2 | 23.14 | |
| Barbre Landing, La | 817.3 | 22.42 | Reading of gauge, Apr. 23. |
| Red River Landing, La | 829.9 | 22.13 | Do. |

HIGH-WATER MARKS OF 1892.

| | | | |
|---|---|---|---|
| Fulton, Ark | 0.0 | 85.09 | Authentic, May 23–24. |
| Brooks Place, Ark | 7.1 | 84.63 | |
| Kye Smith Landing, Ark | 17.1 | 83.87 | Authentic. |
| Ferguson Place, Ark | 24.3 | 82.69 | |
| Dr. Mills Place, Ark | 38.6 | 81.82 | |
| Dooley Ferry, Ark | 41.5 | 81.52 | Do. |
| Simms Island, Ark | 47.5 | 81.21 | |
| Finley Place, Ark | 57.2 | 79.74 | |
| Jane Graham Place, Ark | 60.3 | 79.60 | Do. |
| Dobson Landing, Ark | 65.6 | 79.09 | |
| Person Place, Ark | 72.2 | 78.46 | |
| Person Landing, Ark | 74.9 | 78.20 | |
| Greggs Place, Ark | 81.7 | 77.76 | |
| Haynes Place, Ark | 87.7 | 77.65 | Do. |
| Garland, Ark | 93.2 | 76.76 | Reading of gauge, May 24–25. |
| Cryer Place, Ark | *102.4<br>107.4 | 75.65 | Authentic. |
| Magee Place, Ark | 115.8 | 74.84 | |
| Booker Landing, Ark | 123.9 | 74.39 | Do. |
| California Place, Ark | 131.4 | 74.12 | Do. |
| Cedar Point Place, Ark | 137.7 | 73.44 | Do. |
| Lee Store, Ark | 145.9 | 73.07 | Do. |
| Dukes Bend Landing, Ark | 153.9 | 72.91 | |
| Bell Place, Ark | 160.9 | 72.81 | |

* Measured through Crowell Point Cutoff, Ark.

TABLE 8.—*High-water marks on Red River in Arkansas and Louisiana*—Continued.

HIGH-WATER MARKS OF 1892—Continued.

| Locality. | Distance from Fulton, Ark. | Elevation, Cairo datum. | Remarks. |
|---|---|---|---|
| | *Kilometers.* | *Meters.* | |
| David Sams Place, Ark | 168.5 | 72.70 | |
| Above Sulphur River, Ark | 170.4 | 72.59 | |
| Collins Bluffs, Ark | 173.8 | 72.52 | Authentic. |
| Spring Bank, Ark | 174.4 | 72.50 | Do. |
| Above Diggs Bluffs, Ark | 179.3 | 72.28 | |
| Diggs Bluffs, Ark | 180.1 | 72.26 | |
| Blanton Bluffs, Ark | 189.3 | 71.51 | Do. |
| Upper end of Missionary Place, La | 192.0 | 71.30 | Do. |
| Lower end of Missionary Place, La | 194.5 | 71.25 | Do. |
| Bargetown Slough, La | 195.9 | 71.10 | Do. |
| Boone Bend, La | 200.1 | 70.93 | |
| Above Kouns Canal, La | 205.9 | 70.76 | |
| Kouns Canal, La | 209.2 | 70.67 | |
| Alban Canal, No. 1, La | 211.5 | 70.71 | |
| Posten Bayou, La | 217.2 | 70.06 | |
| One kilometer above Red Bayou, La | 219.8 | 69.42 | |
| Below Red Bayou, La | 221.2 | 68.99 | |
| Fuller Inlet, La | 222.8 | 68.62 | |
| Elmer Slough, La | 226.1 | 68.32 | Do. |
| East Egypt Place, La | 232.0 | 67.46 | |
| Wild Lucia P. O., La | 239.2 | 66.84 | |
| Rush Point, La | 248.5 | 65.70 | Do. |
| Above Cottonwood Bayou, La | 254.4 | 64.34 | Do. |
| Corner Place, La | 255.7 | 64.00 | |
| Willow Bend Place, La | 261.5 | 63.38 | |
| John Eric Place, La | 266.7 | 62.94 | |
| Gold Point Place, La | 273.2 | 62.57 | |
| Hamilton Place, La | 274.0 | 62.36 | |
| Cash Point Place, La | 281.1 | 62.25 | |
| Pandora Bend, La | 288.0 | 62.00 | |
| Below Pandora Bend, La | 288.9 | 61.49 | Uncertain. |
| W. Colquitt Place, La | 295.7 | 60.75 | |
| Shreveport, La | 303.2 | 60.04 | Reading of gauge May 28. |
| Head of Bayou Pierre, La | 306.2 | 59.38 | |
| Above Shreve Cut-off, La | 311.2 | 58.78 | |
| Shreve Cut-off, La | 312.3 | 58.69 | |
| Dan Nicholson Place, La | 312.9 | 58.57 | |
| Curtis Place, La | 319.2 | 58.34 | Authentic. |
| Sunny Point Place, La | 325.3 | 57.20 | |
| Childers Place, La | 331.4 | 56.86 | Do. |
| Lotus Landing, La | 337.5 | 55.92 | Do. |
| Waterloo Cut-off, La | 342.5 | 55.13 | |
| Young Point Cut-off, La | 348.8 | 54.35 | Do. |
| Pascagoula Store, La | 355.2 | 53,66 | |
| Knox Point, La | 361.6 | 53.26 | |
| Caspiana Place, La | 367.9 | 52.91 | Do. |
| White Hall Landing, La | 373.0 | 52.59 | Do. |
| Campo Bello Place, La | 375.1 | 52.45 | |
| Cross Keys Place, La | 382.7 | 51.91 | |
| Ninock Bayou, La | 390.7 | 51.68 | |
| Howard P. O., La | 393.9 | 51.55 | |
| Swift Chute Bayou, La | 395.5 | 51.53 | |
| Rainbow Bend Place, La | 400.0 | 51.30 | |
| Loggy Bayou, La | 405.2 | 50.83 | |
| Mrs. Nelson Place, La | 412.2 | 50.40 | |
| Elder Grove Place, La | 420.4 | 49.98 | Do. |
| Pecan Point Place, La | 429.1 | 48.92 | Do. |
| Willow Point Place, La | 436.8 | 48.66 | Do. |
| Cottage Home Place, La | 441.9 | 47.98 | |
| Glen Martin Place, La | 443.3 | 47.81 | Do. |
| Coushatta, La | 447.8 | 47.35 | Authentic June 5. |
| Dan Giddens Place, La | 455.0 | 46.31 | Authentic. |
| Viva Landing, La | 458.0 | 46.12 | |
| Carnes Place, La | 464.4 | 45.54 | |
| Red Plains Landing, La | 473.5 | 44.77 | |
| Upper Brazil Place, La | 480.1 | 44.14 | |
| Le Compte Bluffs, La | 490.0 | 43.48 | |
| J. C. Henry Place, La | 497.8 | 42.52 | |
| Hyams Place, La | *507.4<br>509.2 | 41.55 | |
| Willow P. O., La | 516.9 | 40.97 | Do. |
| Tessier Landing, La | 526.7 | 39.51 | |
| St. Maurice, La | 537.6 | 39.06 | |
| O. K. Landing, La | 546.8 | 38.35 | Do. |
| High Die Place, La | 554.3 | 37.51 | Do. |
| Montgomery, La | 556.7 | 37.08 | Do. |
| Bell Landing, La | 564.7 | 36.70 | |
| St. Andre Bluffs, La | 574.6 | 36.12 | |

* Measured through Le Vassar Cutoff, La.

TABLE 8.—*High-water marks on Red River in Arkansas and Louisiana*—Continued.

HIGHWATER MARKS OF 1892—Continued.

| Locality. | Distance from Fulton, Ark. | Elevation, Cairo datum. | Remarks. |
|---|---|---|---|
| | *Kilometers.* | *Meters.* | |
| Below St. Andre Bluffs, La | 575.2 | 35.99 | Authentic. |
| Colfax, La | 585.8 | 35.36 | Do. |
| M. E. Landing, La | 593.5 | 34.61 | |
| Kateland Place, La | 597.7 | 34.31 | Do. |
| Fairmount Place, La | 601.0 | 34.01 | |
| Lower Flagland Place, La | 608.2 | 33.47 | |
| Boyce, La | 610.3 | 33.15 | Do. |
| Belleview Landing, La | 616.3 | 32.74 | |
| China Grove Place, La | 625.9 | 32.21 | |
| Myers Place, La | 635.0 | 31.90 | |
| Alexandria, La. (bridge) | 636.9 | 31.59 | Do. |
| Alexandria, La | 640.0 | 31.30 | Reading of gauge June 13. |
| Cut-off Place, La | 648.2 | 30.72 | |
| Hathorn Place, La | 656.2 | 30.07 | |
| Hortensia Landing, La | 665.0 | 29.25 | |
| Casa Landing, La | 672.2 | 28.68 | Authentic. |
| New Poland, La | 676.2 | 28.31 | Do. |
| Grimes Bluff, La | 680.4 | 27.79 | |
| Once More Landing, La | 683.0 | 27.54 | Do. |
| Above Egg Bend Landing, La | 688.3 | 26.82 | |
| Cassandria, La | 697.7 | 25.82 | |
| Dauzat Place, La | 704.7 | 25.22 | |
| Normand Landing, La | 715.1 | 24.28 | |
| Ware Landing, La | 720.4 | 23.86 | |
| Brouillette Landing, La | 727.2 | 23.69 | |
| Saline Bayou, La | 736.2 | 23.55 | |
| Double Eddy, La | 740.7 | 23.50 | |
| Le Prairie Place, La | 744.5 | 23.50 | |
| Murry Landing, La | 748.2 | 23.52 | Do. |
| Old Harris Place, La | 758.3 | 23.46 | |
| Little Larto Landing, La | 763.6 | 23.52 | |
| Black River, La | 772.7 | 23.37 | |
| Red Light Landing, La | 777.5 | 23.30 | |
| Moore Shanty, La | 782.9 | 23.26 | |
| Bayou Cocodrie, La | 792.2 | 23.13 | |
| Red River Bay, La | 797.8 | 23.02 | |
| Marcotte Landing, La | 804.0 | 22.80 | |
| Head Turnbull Island, La | 813.1 | 22.60 | Reading of gauge June 26–29. |
| Barbre Landing, La | 817.3 | 22.45 | Reading of gauge June 28. |
| Red River Landing, La | 829.9 | 22.16 | Reading of gauge June 27. |

*High-water marks on Tones Bayou and Bayou Pierre, Louisiana.*

HIGH-WATER MARKS OF 1884.

| Locality. | Distance from Fulton, Ark. | Elevation, Cairo datum. |
|---|---|---|
| | *Kilometers.* | *Meters.* |
| Head of Tones Bayou | 332.6 | 55.57 |
| Mouth of Tones Bayou | 336.6 | 55.08 |
| Near head of Bayou Chicot | 339.5 | 54.38 |
| Chicot Island | 341.8 | 53.92 |
| Cane Bayou | 344.5 | 53.68 |
| Bennett Bayou | 352.4 | 52.07 |
| Gravel Point | 356.4 | 51.61 |
| Below Gravel Point | 357.6 | 51.58 |
| Do | 358.1 | 51.58 |
| Head of Lake Cunisnia | 358.8 | 51.24 |
| Foot of Lake Cunisnia | 364.7 | 51.24 |
| Near Le Coup Crossing | 365.3 | 51.09 |
| Mouth of Prairie River | 366.9 | 50.67 |
| | 367.8 | 50.58 |
| | 368.2 | 50.52 |
| | 368.5 | 50.52 |
| Head of Watson Bayou | 368.9 | 50.32 |

HIGH-WATER MARKS OF 1885.*

| | | |
|---|---|---|
| Above Lake Pierre | 373.5 | 49.96 |
| Above Folsom Landing | 374.7 | 48.80 |
| Marston Landing | 380.3 | 48.56 |
| King Landing | 394.6 | 46.61 |
| Junction of Bayous Pierre and Wincey | 404.1 | 45.91 |

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* Uncertain.

*High-water marks of 1884 on Bayou La Chute, Louisiana.*

| Locality. | Distance from Fulton, Ark. | Elevation, Cairo datum. | Remarks. |
|---|---|---|---|
| | *Kilometers.* | *Meters.* | |
| Head of Bayou La Chute | 401.2 | ........ | Distance measured down Red River. |
| Near head of Bayou La Chute | 403.7 | 50.54 | |
| Mouth of Bayou La Chute | 407.4 | 50.47 | |
| Head of Watson Bayou | 408.7<br>368.9 | 50.32 | Distance 368.9, measured down Tones Bayou and Bayou Pierre. |

*High-water marks of 1885 on Grand Bayou, Louisiana.**

| | | | |
|---|---|---|---|
| Head of Grand Bayou | 428.3 | ........ | Distance measured down Red River. |
| | 429.5 | 49.01 | |
| | 430.1 | 48.95 | |
| | 430.5 | 48.86 | |
| Marston Landing | 434.1<br>380.3 | 48.56 | Distance 380.3, measured down Tones Bayou and Bayou Pierre. |

* Uncertain.

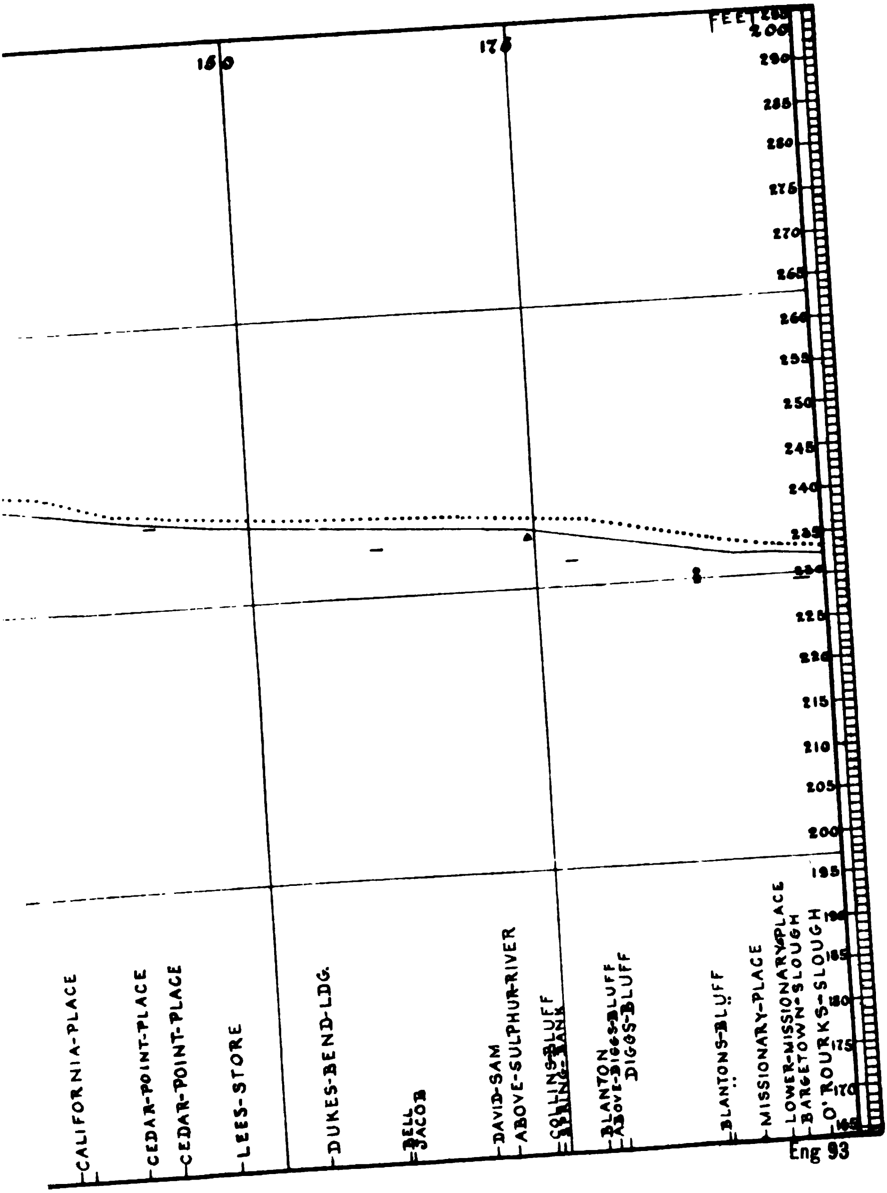
TABLE 9.—*Elevation of zeros of gauges on Red River from Fulton, Ark., to Red River Landing, La., at the mouth.*

| Locality. | Established by— | Elevation of zero referred to Cairo datum. |
|---|---|---|
| | | *Meters.* |
| Fulton, Ark | United States Engineers | +74.61 |
| Garland, Ark | do | +68.11 |
| Collins Bluff, Ark | do | +64.94 |
| Shreveport, La | do | +49.15 |
| Coushatta, La | do | +35.33 |
| Alexandria, La | do | +19.65 |
| Barbre Landing, La | do | +7.31 |
| Red River Landing, La | do | +7.27 |

TABLE 10.—*Discharge observations in Red River, tributaries, and outlets.*

| Locality. | Date. | Area. | Maximum mid-depth velocities. | Discharge. | Elevation of water surface, Cairo datum. | Stage below maximum high water. | Method. |
|---|---|---|---|---|---|---|---|
| | | *Square meters.* | *Meters.* | *Cubic meters.* | *Meters.* | *Meters.* | |
| Pandora Bend. | Feb. 19, 1872 | 94 | 0.68 | 50 | 57.40 | 4.6 | Mid-depth floats. |
| M. Barr Place. | Feb. 20, 1872 | 91 | 0.70 | 52 | 57.05 | 4.6 | Do. |
| Mulhaupt Place. | Feb. 21, 1872 | 130 | 0.63 | 67 | 56.70 | 4.7 | Do. |
| E. B. Herndon Place. | Feb. 28, 1872 | 151 | 0.54 | 59 | 55.70 | *4.7 | Do. |
| Twelve Mile Bayou ½ kilometer above mouth. | Feb. 29, 1872 | 391 | 0.66 | 198 | 55.35 | ........ | Do. |
| Cross Bayou, near mouth. | ....do | 686 | 0.52 | 313 | 55.00 | *5.1 | Do. |
| Shreveport (near Silver Lake), La. | Feb. 28, 1872 | 1,461 | 0.45 | 491 | 54.60 | *5.4 | Do. |
| One kilometer below Curtis, La. | Mar. 4, 1872 | 588 | 1.16 | 529 | 54.60 | 3.5 | Do. |
| Red River above Tones Bayou. | Mar. 11, 1872 | 460 | 1.02 | 369 | 52.50 | 4.4 | Do. |
| Red River below Tones Bayou. | ....do | 181 | 1.25 | 165 | 52.40 | 4.5 | Do. |

* Difference in stage due to altered slope, 1872 to 1892.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CALIFORNIA-PLACE
CEDAR-POINT-PLACE
CEDAR-POINT-PLACE
LEES-STORE
DUKES-BEND-LDG.
BELL
JACOB
DAVID-SAM
ABOVE-SULPHUR-RIVER
COLLINS-BLUFF
SPRING-BANK
BLANTON
ABOVE-DIGGS-BLUFF
DIGGS-BLUFF
BLANTONS-BLUFF
MISSIONARY-PLACE
LOWER-MISSIONARY-PLACE
BARGETOWN-SLOUGH
O'ROURKS-SLOUGH
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High-water marks of 18[illegible] on Bayou La Chute, Louisiana.

| Landing. | Distance from Fulton, Ark. | Elevation, Cairo datum. | Remarks. |
|---|---|---|---|
| | Kilometers. | Meters. | |
| Head of Bayou La Chute | [illegible] | | Distance measured<br>Red River. |
| Near head of Bayou La Chute | [illegible] | [illegible] | |
| Mouth of Bayou La Chute | [illegible] | [illegible] | |
| Head of Watson Bayou | [illegible]<br>[illegible] | [illegible] | Distance [illegible]<br>[illegible] Tones Bay<br>Bayou Pierre. |

High water marks of 18[illegible] on Grand Bayou, Louisiana.*

| | | | |
|---|---|---|---|
| Head of Grand Bayou | [illegible] | | Distance measured<br>Red River. |
| | [illegible] | [illegible] | |
| | [illegible] | [illegible] | |
| | [illegible] | [illegible] | |
| Marlon Landing | [illegible]<br>[illegible] | [illegible] | Distance [illegible]<br>[illegible] Tones Bay<br>Bayou Pierre. |

* Uncertain.

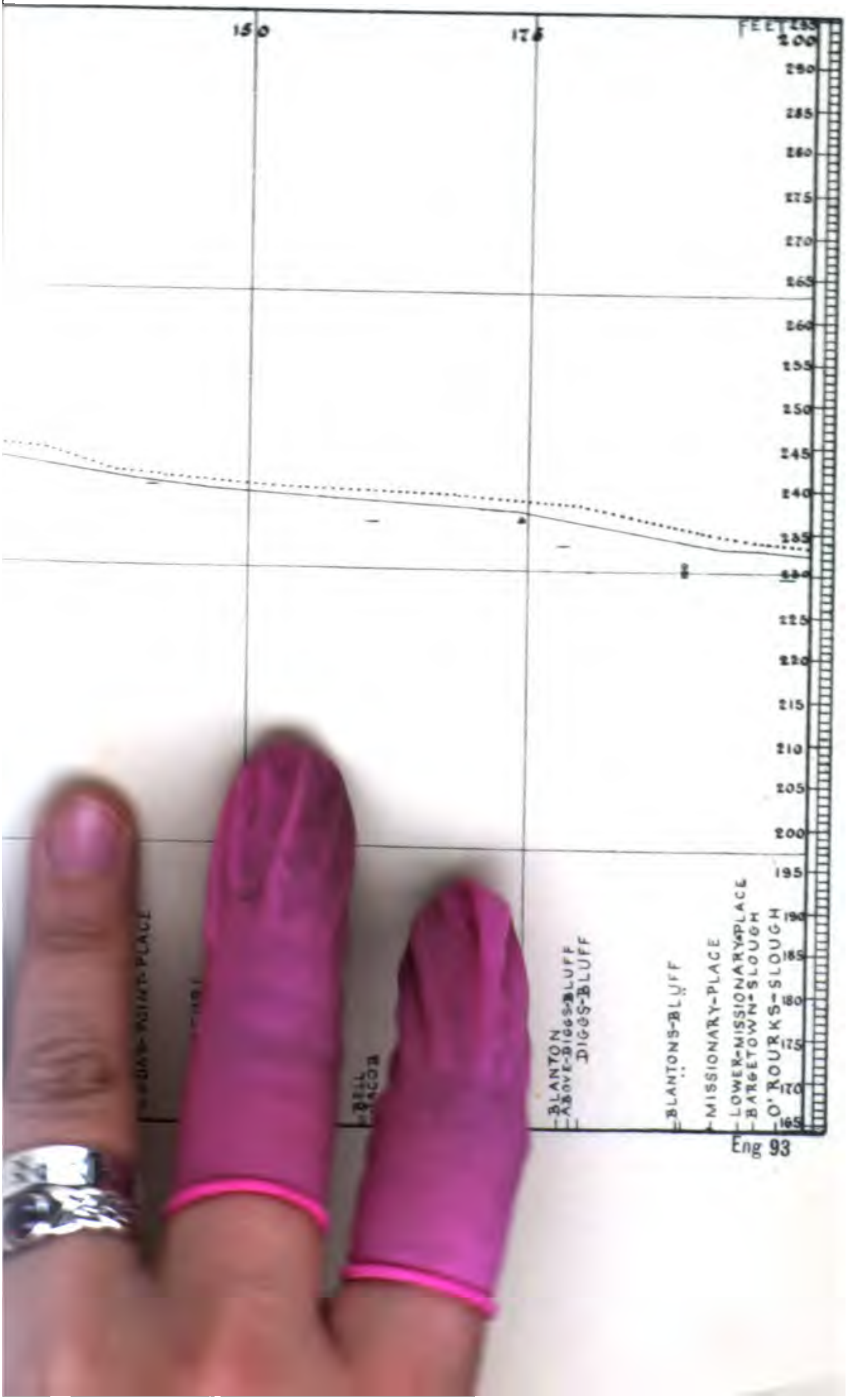
TABLE 9.—Elevation of zeros of gauges on Red River from Fulton, Ark., to Red River Landing, La., at the mouth.

| Locality. | Established by— | Ele of z Cai |
|---|---|---|
| Fulton, Ark. | United States Engineers | |
| Garland, Ark. | do | |
| [illegible], Ark. | do | |
| Shreveport, La. | do | |
| [illegible], La. | do | |
| Alexandria, La. | do | |
| [illegible] Landing, La. | do | |
| Red River Landing, La. | do | |

TABLE 10.—Discharge observations in Red River, tributaries, and outlets.

| Locality. | Date. | Area. | Maximum mid-depth velocities. | Discharge. | Elevation of water surface, Cairo datum. | Stage below maximum high water. | Method |
|---|---|---|---|---|---|---|---|
| | | Square meters. | Meters. | Cubic meters. | Meters. | Meters. | |
| Pandora Bend. | Feb. 19, 1879 | 94 | 0.68 | 50 | 57.40 | 4.[illegible] | |
| M. Barr Place. | Feb. 20, 1879 | 91 | 0.70 | 52 | 57.05 | 4.[illegible] | |
| Mulhaupt Place. | Feb. 21, 1879 | 130 | 0.63 | 67 | 56.70 | 4.[illegible] | |
| E. B. Herndon Place. | Feb. 24, 1879 | 151 | 0.54 | 59 | 55.70 | * | |
| Twelve Mile Bayou, ½ kilometer above mouth. | Feb. 26, 1879 | 391 | 0.66 | 198 | 55.35 | | |
| Cross Bayou, near mouth. | do | 686 | 0.52 | 313 | 55.[illegible] | | |
| Shreveport (near Silver Lake), La. | Feb. 28, 1879 | 1,461 | 0.45 | 491 | 54.[illegible] | | |
| One kilometer below Curtis, La. | Mar. 4, 1879 | 588 | 1.16 | 629 | | | |
| Red River above Tones Bayou. | Mar. 11, 1879 | 400 | 1.02 | [illegible] | | | |
| Red River below Tones Bayou. | do | 191 | 1.25 | | | | |

* Difference in stage due to altered a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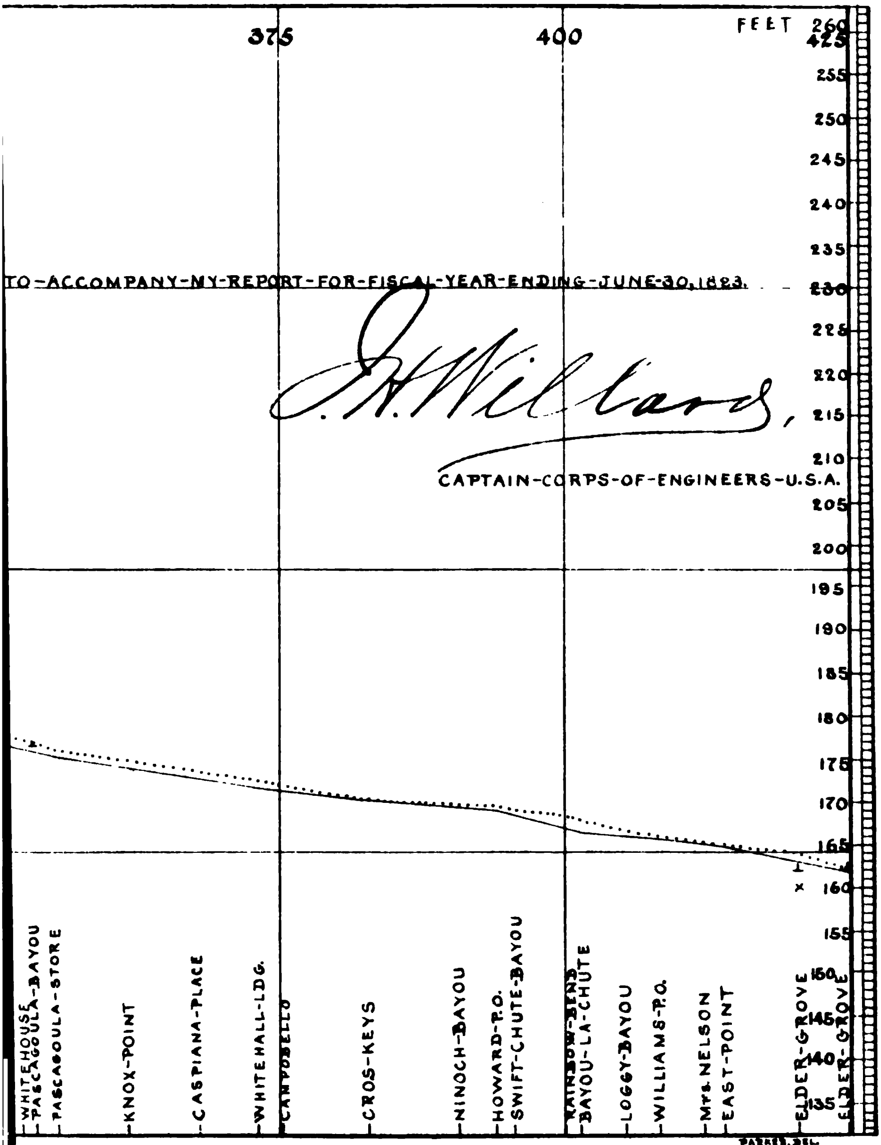
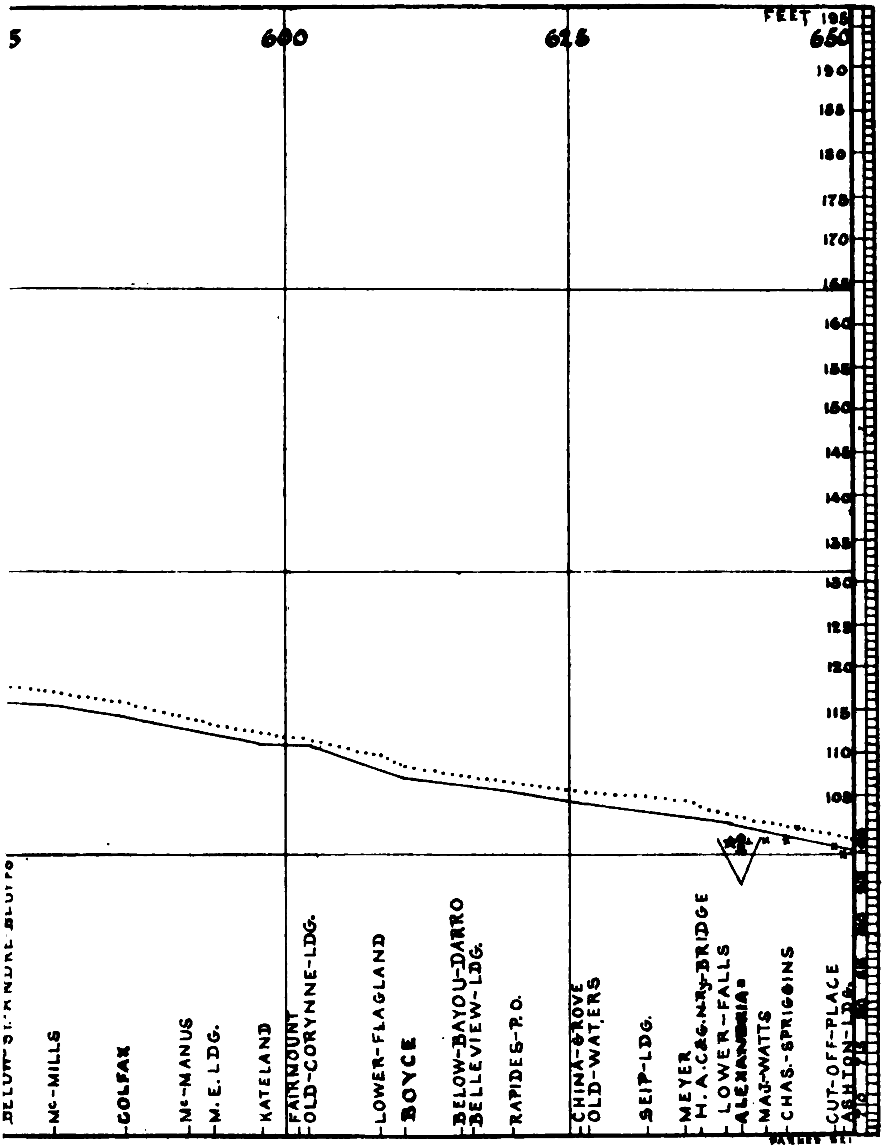


TO-ACCOMPANY-MY-REPORT-FOR-FISCAL-YEAR-ENDING-JUNE-30,1883.

J. H. Willard,

CAPTAIN-CORPS-OF-ENGINEERS-U.S.A.

PARKER, DEL.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Mc-MILLS
COLFAX
Mc-MANUS
M. E. LDG.
KATELAND
FAIRMOUNT
OLD-CORYNNE-LDG.
LOWER-FLAGLAND
BOYCE
BELOW-BAYOU-DARRO
BELLEVIEW-LDG.
RAPIDES-P.O.
CHINA-GROVE
OLD-WATERS
SEIP-LDG.
MEYER
H. A. C&G. N. Ry. BRIDGE
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MAJ.-WATTS
CHAS.-SPRIGGINS
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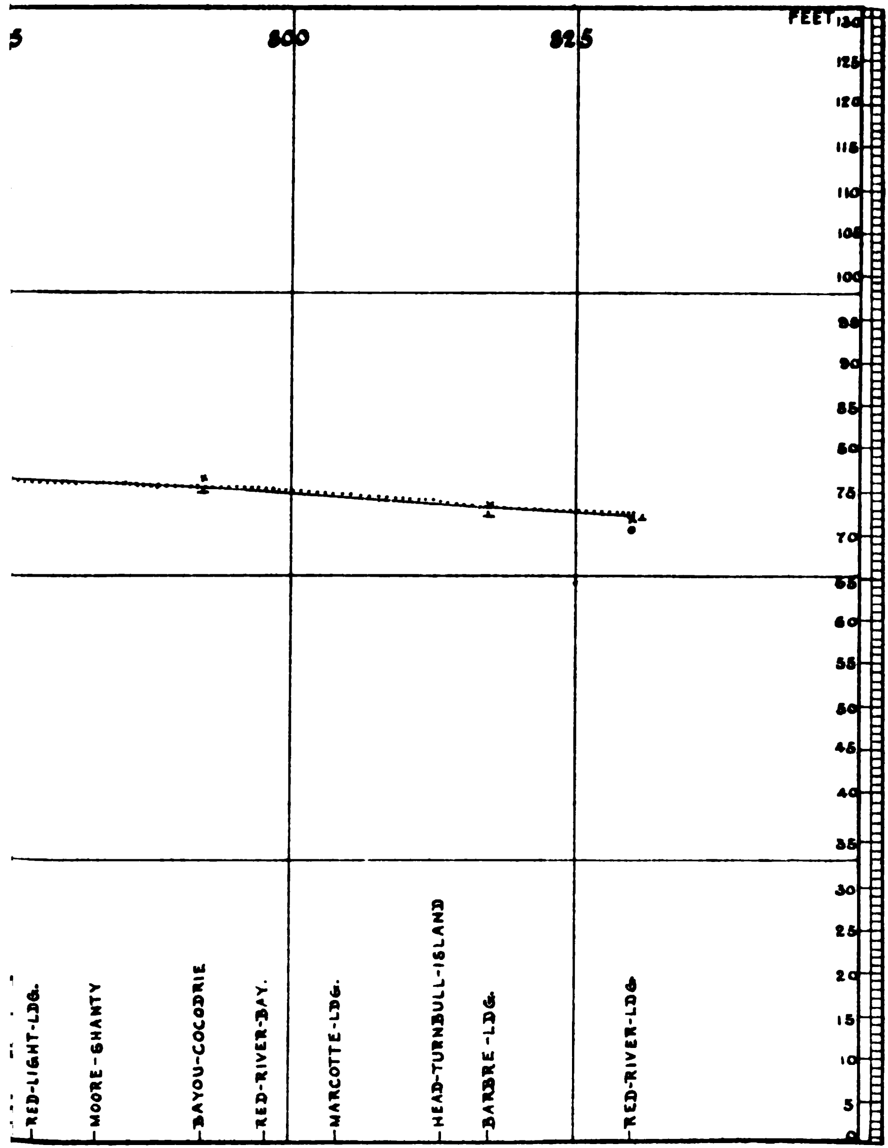
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RED-LIGHT-LDG.
MOORE-SHANTY
BAYOU-COCODRIE
RED-RIVER-BAY.
MARCOTTE-LDG.
HEAD-TURNBULL-ISLAND
BARBRE-LDG.
RED-RIVER-LDG.

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TABLE 10.—*Discharge observations in Red River, tributaries, and outlets*—Continued.

| Locality. | Date. | Area. | Maximum mid-depth velocities. | Discharge. | Elevation of water surface, Cairo datum. | Stage below maximum high water. | Method. |
|---|---|---|---|---|---|---|---|
| | | *Square meters.* | *Meters.* | *Cubic meters.* | *Meters.* | *Meters.* | |
| Tones Bayou (outlet). | Mar. 11, 1872 | 302 | 1.00 | 243 | 52.30 | 4.6 | Mid-depth floats. |
| Bayou Pierre, above Tones Bayou (outlet). | Mar. 12, 1872 | 183 | 0.16 | 18 | 51.55 | ........ | Do. |
| Bayou Pierre, below Tones Bayou (outlet). | ....do ....... | 278 | 1.06 | 221 | 51.55 | ........ | Do. |
| Red River above Tones Bayou. | Feb. 3, 1887 | 568 | 0.58 | 146 | 50.51 | 6.3 | Rod floats. |
| Do ................ | Feb. 8, 1887 | 556 | 0.40 | 153 | 50.39 | 6.4 | Do. |
| Do ................ | Feb. 10, 1887 | 568 | 0.37 | 152 | 50.54 | 6.3 | Do. |
| Do ................ | Feb. 11, 1887 | 567 | 0.50 | 182 | 50.67 | 6.1 | Do. |
| Do ................ | Feb. 12, 1887 | 605 | 0.41 | 199 | 50.88 | 5.9 | Do. |
| Do ................ | Feb. 15, 1887 | 698 | 0.54 | 279 | 51.43 | 5.4 | Do. |
| Do ................ | Feb. 16, 1887 | 723 | 0.62 | 311 | 51.58 | 5.2 | Do. |
| Do ................ | Feb. 17, 1887 | ........ | ........ | 333 | 51.71 | 5.1 | Interpolated. |
| Do ................ | Feb. 18, 1887 | 754 | 0.58 | 360 | 51.87 | 4.9 | Rod floats. |
| Do ................ | Feb. 19, 1887 | ........ | ........ | 394 | 52.00 | 4.8 | Interpolated. |
| Do ................ | Feb. 21, 1887 | 829 | 0.67 | 479 | 52.32 | 4.5 | Rod floats. |
| Do ................ | Feb. 22, 1887 | 843 | 0.68 | 440 | 52.46 | 4.3 | Do. |
| Do ................ | Feb. 23, 1887 | 905 | 0.73 | 436 | 52.59 | 4.2 | Do. |
| Do ................ | Feb. 24, 1887 | 925 | 0.85 | 614 | 52.76 | 4.0 | Do. |
| Do ................ | Feb. 25, 1887 | 938 | 0.79 | 525 | 52.92 | 3.9 | Do. |
| Do ................ | Feb. 28, 1887 | 1,006 | 0.75 | 584 | 53.33 | 3.5 | Current meter. |
| Do ................ | Mar. 1, 1887 | 1,012 | 0.75 | 539 | 53.41 | 3.4 | Do. |
| Do ................ | Mar. 2, 1887 | ........ | ........ | 567 | 53.46 | 3.3 | Interpolated. |
| Do ................ | Mar. 3, 1887 | 1,004 | 0.81 | 586 | 53.49 | 3.3 | Current meter. |
| Do ................ | Mar. 4, 1887 | 1,004 | 0.82 | 564 | 53.51 | 3.3 | Do. |
| Do ................ | Mar. 5, 1887 | 1,004 | 0.81 | 607 | 53.51 | 3.3 | Do. |
| Do ................ | Mar. 7, 1887 | 1,025 | 0.84 | 647 | 53.59 | 3.2 | Do. |
| Red River below Tones Bayou. | Jan. 29, 1887 | 198 | 0.58 | 101 | 50.37 | 6.4 | Rod floats. |
| Do ................ | Jan. 31, 1887 | 210 | 0.62 | 86 | 50.52 | 6.3 | Do. |
| Do ................ | Feb. 2, 1887 | 210 | 0.73 | 101 | 50.52 | 6.3 | Do. |
| Do ................ | Feb. 7, 1887 | 198 | 0.78 | 123 | 50.40 | 6.4 | Do. |
| Do ................ | Feb. 9, 1887 | 207 | 0.76 | 129 | 50.44 | 6.4 | Do. |
| Do ................ | Feb. 11, 1887 | 219 | 0.88 | 135 | 50.67 | 6.1 | Do. |
| Do ................ | Feb. 16, 1887 | 284 | 0.78 | 183 | 51.58 | 5.2 | Do. |
| Do ................ | Feb. 18, 1887 | 304 | 0.62 | 193 | 51.87 | 4.9 | Do. |
| Do ................ | Feb. 21, 1887 | 391 | 1.04 | 328 | 52.32 | 4.5 | Do. |
| Do ................ | Feb. 23, 1887 | 412 | 0.96 | 327 | 52.59 | 4.2 | Do. |
| Do ................ | Feb. 25, 1887 | 433 | 0.97 | 356 | 52.92 | 3.9 | Do. |
| Do ................ | Mar. 1, 1887 | ........ | ........ | 347 | 53.41 | 3.4 | Interpolated. |
| Do ................ | Mar. 2, 1887 | 458 | 0.97 | 346 | 53.46 | 3.3 | Current meter. |
| Do ................ | Mar. 4, 1887 | 468 | 0.93 | 361 | 53.51 | 3.3 | Do. |
| Do ................ | Mar. 7, 1887 | 467 | 0.94 | 364 | 53.59 | 3.2 | Do. |
| Tones Bayou (outlet)........ | Jan. 29, 1887 | 231 | 0.28 | 40 | 50.37 | ........ | Rod floats. |
| Do ................ | Feb. 15, 1887 | 349 | 0.43 | 88 | 51.43 | ........ | Do. |
| Do ................ | Feb. 17, 1887 | 371 | 0.38 | 99 | 51.71 | ........ | Do. |
| Do ................ | Feb. 19, 1887 | 389 | 0.54 | 157 | 52.00 | ........ | Do. |
| Do ................ | Feb. 22, 1887 | 425 | 0.58 | 190 | 52.46 | ........ | Do. |
| Do ................ | Feb. 24, 1887 | 449 | 0.67 | 232 | 52.76 | ........ | Do. |
| Do ................ | Mar. 1, 1887 | 501 | 0.74 | 255 | 53.41 | ........ | Current meter. |
| Do ................ | Mar. 3, 1887 | 501 | 0.73 | 260 | 53.49 | ........ | Do. |
| Do ................ | Mar. 5, 1887 | 504 | 0.83 | 273 | 53.51 | ........ | Do. |
| Old River below Tones Bayou.* | Feb. 24, 1887 | 79 | 0.44 | 14 | 52.76 | ........ | Rod floats. |
| Do ................ | Mar. 1, 1887 | 119 | 0.28 | 18 | 53.41 | ........ | Current meter. |
| Do ................ | Mar. 3, 1887 | 124 | 0.27 | 21 | 53.49 | ........ | Do. |
| Do ................ | Mar. 5, 1887 | 124 | 0.37 | 30 | 53.51 | ........ | Do. |
| Missionary, La............ | Nov. 21, 1891 | 187 | ........ | 65 | 63.23 | 8.1 | Rod floats. |
| Red River above Bargetown Slough. | Jan. 20, 1891 | 1,017 | 1.20 | 1,304 | 69.75 | 1.2 | Surface floats. |
| Bargetown Slough (outlet.) | ....do ....... | 252 | 1.25 | 323 | 69.40 | 1.7 | Do. |
| O'Rouke Slough (outlet)... | Jan. 22, 1891 | 54 | 0.75 | 48 | 69.45 | 1.5 | Do. |
| Kouns Canal (outlet)....... | Jan. 26, 1891 | 75 | 0.85 | 74 | 68.67 | 2.1 | Do. |
| Hervey Canal (outlet)...... | Jan. 29, 1891 | 76 | 0.85 | 67 | 67.97 | 2.5 | Do. |
| Red Bayou (outlet).......... | Jan. 31, 1891 | 126 | 0.96 | 124 | 67.56 | 1.8 | Do. |
| Dooley Bayou (outlet)...... | Feb. 4, 1891 | 237 | 1.07 | 258 | 66.60 | 0.9 | Do. |
| Cottonwood Bayou (outlet). | Feb. 10, 1891 | 196 | 1.59 | 307 | 63.67 | 0.6 | Do. |
| Red River below Cottonwood Bayou. | Feb. 11, 1891 | 441 | 1.15 | 534 | 63.80 | 0.5 | Do. |

* Return flow into river.

TABLE 10.—*Discharge observations in Red River, tributaries, and outlets*—Continued.

| Locality. | Date. | Area. | Maximum mid-depth velocities. | Discharge. | Elevation of water surface, Cairo datum. | Stage below maximum high water. | Method. |
|---|---|---|---|---|---|---|---|
| | | *Square meters.* | *Meters.* | *Cubic meters.* | *Meters.* | *Meters.* | |
| Red River above Twelve Mile Bayou. | Feb. 19, 1891 | 504 | 0.92 | 359 | *56.43 | 3.6 | Current meter. |
| Do | Feb. 21, 1891 | 511 | 0.72 | 306 | *56.48 | 3.5 | Do. |
| Do | Feb. 25, 1891 | 474 | 0.73 | 269 | *56.04 | 4.0 | Do. |
| Do | Feb. 28, 1891 | 453 | 0.83 | 273 | *55.69 | 4.3 | Do. |
| Twelve-Mile Bayou (tributary). | Feb. 21, 1891 | 576 | 1.20 | 523 | *56.48 | 3.5 | Do. |
| Do | Feb. 25, 1891 | 546 | 1.15 | 454 | *56.04 | 4.0 | Do. |
| Do | Feb. 27, 1891 | 522 | 1.12 | 450 | *55.82 | 4.2 | Do. |
| Do | Feb. 28, 1891 | ........ | ........ | 448 | *55.69 | 4.3 | Interpolated. |
| Cross Bayou (tributary) | Feb. 23, 1891 | 1,151 | 0.81 | 694 | *56.31 | 3.7 | Current meter. |
| Do | Feb. 25, 1891 | ........ | ........ | 610 | *56.04 | 4.0 | Interpolated. |
| Do | Feb. 26, 1891 | 1,100 | 0.71 | 576 | *55.93 | 4.1 | Current meter. |
| Do | Feb. 28, 1891 | 1,075 | 0.62 | 500 | *55.69 | 4.3 | Do. |
| Shreveport, La. (below railroad bridge). | Feb. 23, 1891 | 1,907 | 0.99 | 1,424 | *56.31 | 3.7 | Do. |
| Do | Feb. 25, 1891 | ........ | ........ | 1,334 | *56.04 | 4.0 | Interpolated. |
| Do | Feb. 26, 1891 | 1,824 | 0.93 | 1,298 | *55.93 | 4.1 | Current meter. |
| Do | Feb. 27, 1891 | ........ | ........ | 1,286 | *55.82 | 4.2 | Interpolated. |
| Do | Feb. 28, 1891 | 1,784 | 0.90 | 1,271 | *55.69 | 4.3 | Current meter. |
| Red River above Tones Bayou. | Apr. 20, 1891 | 931 | 0.83 | 685 | †52.80 | 3.9 | Do. |
| Do | Apr. 21, 1891 | 931 | 0.83 | 669 | †52.85 | 3.9 | Do. |
| Do | Apr. 22, 1891 | ........ | ........ | 706 | †53.00 | 3.7 | Interpolated. |
| Do | Apr. 23, 1891 | 991 | 0.86 | 767 | †53.24 | 3.5 | Current meter. |
| Do | Apr. 24, 1891 | 1,006 | 0.88 | 779 | †53.38 | 3.4 | Do. |
| Do | Apr. 25, 1891 | 1,020 | 0.88 | 785 | †53.45 | 3.4 | Do. |
| Do | Apr. 27, 1891 | 1,035 | 0.89 | 825 | †53.60 | 3.2 | Do. |
| Do | Apr. 28, 1891 | 1,050 | 0.92 | 880 | †53.69 | 3.0 | Do. |
| Red River below Tones Bayou. | Apr. 20, 1891 | 521 | 1.19 | 542 | ........ | ........ | Do. |
| Do | Apr. 21, 1891 | 521 | 1.22 | 544 | ........ | ........ | Do. |
| Do | Apr. 22, 1891 | 528 | 1.22 | 572 | ........ | ........ | Do. |
| Do | Apr. 23, 1891 | 550 | 1.29 | 626 | ........ | ........ | Do. |
| Do | Apr. 24, 1891 | 557 | 1.28 | 629 | ........ | ........ | Do. |
| Do | Apr. 25, 1891 | 565 | 1.29 | 640 | ........ | ........ | Do. |
| Do | Apr. 27, 1891 | 573 | 1.31 | 609 | ........ | ........ | Do. |
| Do | Apr. 28, 1891 | 580 | 1.32 | 677 | ........ | ........ | Do. |
| Tones Bayou (outlet) | Apr. 20, 1891 | ........ | ........ | 160 | ........ | ........ | Interpolated. |
| Do | Apr. 21, 1891 | 570 | 0.40 | 160 | ........ | ........ | Current meter. |
| Do | Apr. 22, 1891 | 579 | 0.40 | 160 | ........ | ........ | Do. |
| Do | Apr. 23, 1891 | 604 | 0.48 | 188 | ........ | ........ | Do. |
| Do | Apr. 24, 1891 | 612 | 0.45 | 201 | ........ | ........ | Do. |
| Do | Apr. 25, 1891 | 621 | 0.44 | 175 | ........ | ........ | Do. |
| Do | Apr. 27, 1891 | 629 | 0.52 | 236 | ........ | ........ | Do. |
| Do | Apr. 28, 1891 | 638 | 0.48 | 247 | ........ | ........ | Do. |
| Red River above Loggy Bayou. | May 1, 1891 | 597 | 1.45 | 668 | ‡44.72 | 6.1 | Do. |
| Do | May 2, 1891 | 612 | 1.39 | 679 | ‡44.83 | 6.0 | Do. |
| Do | May 4, 1891 | 627 | 1.45 | 700 | ‡44.96 | 5.8 | Do. |
| Do | May 5, 1891 | 642 | 1.48 | 755 | ‡45.06 | 5.7 | Do. |
| Do | May 6, 1891 | 656 | 1.42 | 785 | ‡45.14 | 5.7 | Do. |
| Do | May 7, 1891 | 672 | 1.52 | 807 | ‡45.23 | 5.6 | Do. |
| Do | May 8, 1891 | 686 | 1.47 | 818 | ‡45.31 | 5.5 | Do. |
| Do | May 9, 1891 | 695 | 1.58 | 852 | ‡45.37 | 5.4 | Do. |
| Red River below Loggy Bayou. | May 4, 1891 | 703 | 1.32 | 800 | ........ | ........ | Do. |
| Do | May 5, 1891 | 716 | 1.41 | 859 | ........ | ........ | Do. |
| Do | May 6, 1891 | 735 | 1.35 | 853 | ........ | ........ | Do. |
| Do | May 7, 1891 | 742 | 1.38 | 900 | ........ | ........ | Do. |
| Do | May 8, 1891 | 755 | 1.44 | 900 | ........ | ........ | Do. |
| Do | May 9, 1891 | 762 | 1.46 | 884 | ........ | ........ | Do. |
| Loggy Bayou (tributary) | May 1, 1891 | 281 | 0.66 | 142 | ........ | ........ | Do. |
| Do | May 2, 1891 | 286 | 0.63 | 136 | ........ | ........ | Do. |
| Do | May 4, 1891 | 290 | 0.63 | 137 | ........ | ........ | Do. |
| Do | May 5, 1891 | 295 | 0.56 | 123 | ........ | ........ | Do. |
| Do | May 6, 1891 | 300 | 0.52 | 119 | ........ | ........ | Do. |
| Do | May 7, 1831 | 305 | 0.51 | 114 | ........ | ........ | Do. |
| Do | May 8, 1891 | 310 | 0.49 | 113 | ........ | ........ | Do. |
| Do | May 9, 1891 | 313 | 0.48 | 111 | ........ | ........ | Do. |

* Gauge read at Shreveport, La.

† Gauge read at head of Tones Bayou.

‡ Gauge read at mouth of Loggy Bayou.

TABLE 10.—*Discharge observations in Red River, tributaries, and outlets*—Continued.

| Locality. | Date. | Area. | Maximum mid-depth velocities. | Discharge. | Elevation of water surface, Cairo datum. | Stage below maximum high water. | Method. |
|---|---|---|---|---|---|---|---|
| | | *Square meters.* | *Meters.* | *Cubic meters.* | *Meters.* | *Meters.* | |
| Red River above Bayou Wincey. | May 15, 1891 | 903 | 1.25 | 955 | | | Current meter. |
| Do | May 16, 1891 | | | 951 | | | Interpolated. |
| Do | May 18, 1801 | 870 | 1.22 | 922 | | | Current meter. |
| Do | May 19, 1891 | 843 | 1.19 | 907 | | | Do. |
| Do | May 20, 1891 | 788 | 1.18 | 828 | | | Do. |
| Do | May 21, 1891 | 771 | 1.27 | 822 | | | Do. |
| Do | May 22, 1801 | 791 | 1.21 | 807 | | | Do. |
| Do | May 23, 1891 | 769 | 1.16 | 782 | | | Do. |
| Red River below Bayou Wincey. | May 14, 1891 | 1,364 | 1.49 | 1,575 | *40.39 | 6.3 | Do. |
| Do | May 15, 1891 | 1,364 | 1.40 | 1,578 | *40.38 | 6.3 | Do. |
| Do | May 16, 1891 | 1,364 | 1.36 | 1,505 | *40.37 | 6.3 | Do. |
| Do | May 18, 1891 | 1,338 | 1.32 | 1,492 | *40.29 | 6.4 | Do. |
| Do | May 19, 1891 | 1,314 | 1.28 | 1,432 | *40.21 | 6.5 | Do. |
| Do | May 20, 1891 | 1,293 | 1.27 | 1,398 | *40.12 | 6.6 | Do. |
| Do | May 21, 1891 | 1,265 | 1.26 | 1,336 | *40.00 | 6.7 | Do. |
| Do | May 22, 1891 | 1,239 | 1.24 | 1,303 | *39.87 | 6.8 | Do. |
| Do | May 23, 1891 | 1,215 | 1.23 | 1,258 | *39.75 | 6.9 | Do. |
| Bayou Wincey (tributary) | May 14, 1891 | 486 | 1.48 | 562 | | | Do. |
| Do | May 15, 1891 | 486 | 1.47 | 550 | | | Do. |
| Do | May 16, 1801 | 486 | 1.43 | 542 | | | Do. |
| Do | May 18, 1891 | 478 | 1.41 | 537 | | | Do. |
| Do | May 19, 1891 | 473 | 1.46 | 536 | | | Do. |
| Do | May 20, 1891 | 466 | 1.39 | 500 | | | Do. |
| Do | May 21, 1891 | 458 | 1.39 | 487 | | | Do. |
| Do | May 22, 1891 | 451 | 1.33 | 467 | | | Do. |
| Do | May 23, 1891 | 445 | 1.28 | 443 | | | Do. |
| Red River above head of Cane River. | May 28, 1891 | 883 | 1.48 | 1,011 | | | Do. |
| Do | May 29, 1891 | 854 | 1.42 | 964 | | | Do. |
| Do | May 30, 1891 | 840 | 1.33 | 896 | | | Do. |
| Do | June 1, 1891 | 770 | 1.31 | 807 | | | Do. |
| Do | June 2, 1891 | 758 | 1.38 | 761 | | | Do. |
| Do | June 3, 1891 | 746 | 1.31 | 730 | | | Do. |
| Do | June 4, 1891 | 721 | 1.34 | 691 | | | Do. |
| Do | June 5, 1891 | 609 | 1.28 | 687 | | | Do. |
| Head of Cane River (outlet). | May 27, 1891 | 83 | 0.72 | 46 | †33.14 | 8.0 | Do. |
| Do | May 28, 1891 | 74 | 0.68 | 39 | †32.96 | 8.1 | Do. |
| Do | May 29, 1891 | 66 | 0.66 | 34 | †32.79 | 8.3 | Do. |
| Do | May 30, 1891 | 62 | 0.60 | 30 | †32.63 | 8.5 | Do. |
| Do | June 1, 1891 | 51 | 0.53 | 20 | †32.33 | 8.8 | Do. |
| Do | June 2, 1891 | 48 | 0.46 | 16 | †32.17 | 8.9 | Do. |
| Do | June 3, 1891 | 44 | 0.41 | 13 | †32.04 | 9.1 | Do. |
| Do | June 4, 1891 | 38 | 0.38 | 11 | †31.92 | 9.2 | Do. |
| Do | June 5, 1891 | 35 | 0.33 | 9 | †31.83 | 9.3 | Do. |
| Red River below head of Cane River. | May 27, 1891 | 976 | 1.43 | 1,020 | | | Do. |
| Do | May 28, 1891 | 943 | 1.43 | 974 | | | Do. |
| Do | May 29, 1891 | 910 | 1.42 | 904 | | | Do. |
| Do | May 30, 1891 | 894 | 1.39 | 874 | | | Do. |
| Do | June 1, 1891 | 845 | 1.35 | 800 | | | Do. |
| Do | June 2, 1891 | 829 | 1.31 | 760 | | | Do. |
| Do | June 3, 1891 | 813 | 1.31 | 714 | | | Do. |
| Do | June 4, 1891 | 781 | 1.31 | 701 | | | Do. |
| Do | June 5, 1891 | 765 | 1.34 | 698 | | | Do. |
| Red River above mouth of Cane River. | June 8, 1891 | 662 | 1.21 | 633 | ‡25.71 | 9.7 | Do. |
| Do | June 9, 1891 | 652 | 1.21 | 618 | ‡25.61 | 9.8 | Do. |
| Do | June 10, 1891 | 642 | 1.20 | 598 | ‡25.54 | 9.9 | Do. |
| Do | June 11, 1891 | 642 | 1.20 | 592 | ‡25.47 | 9.9 | Do. |
| Do | June 12, 1891 | 632 | 1.19 | 590 | ‡25.40 | 10.0 | Do. |
| Month of Cane River (tributary). | June 8, 1891 | | | No discharge. | | | Do. |
| Red River below mouth of Cane River. | ....do | 738 | 1.02 | 609 | | | Do. |
| Do | June 9, 1891 | 724 | 1.08 | 607 | | | Do. |
| Do | June 10, 1891 | 709 | 1.07 | 592 | | | Do. |
| Do | June 11, 1891 | 709 | 1.05 | 598 | | | Do. |
| Do | June 12, 1891 | 694 | 0.99 | 571 | | | Do. |

*Gauge read at mouth of Bayou Wincey.
†Gauge read at head of Cane River.
‡Gauge read at mouth of Cane River.

**TABLE 10.**—*Discharge observations in Red River, tributaries, and outlets*—Continued.

| Locality. | Date. | Area. | Maximum mid-depth velocities. | Discharge. | Elevation of water surface, Cairo datum. | Stage below maximum high water. | Method. |
|---|---|---|---|---|---|---|---|
| | | *Square meters.* | *Meters.* | *Cubic meters.* | *Meters.* | *Meters.* | |
| Above Alexandria, La | June 13, 1891 | 625 | 0.99 | 530 | ........ | ........ | Currente meter. |
| Do | June 20, 1891 | 723 | 1.02 | 646 | ........ | ........ | Do. |
| Do | July 9, 1891 | 939 | 1.15 | 921 | ........ | ........ | Do. |
| Do | July 31, 1891 | 416 | 0.83 | 290 | ........ | ........ | Do. |
| Do | Aug. 10, 1891 | 453 | 0.86 | 340 | ........ | ........ | Do. |
| Do | Aug. 17, 1891 | 566 | 0.91 | 448 | ........ | ........ | Do. |
| Do | Aug. 24, 1891 | 549 | 0.92 | 434 | ........ | ........ | Do. |
| Do | Aug. 29, 1891 | 508 | 0.86 | 363 | ........ | ........ | Do. |
| Alexandria, La., Bayou Rapids (tributary). | June 20, 1891 | 3 | 0.23 | 0.6 | ........ | ........ | Do. |
| Do | July 9, 1891 | 10 | 0.26 | 2.4 | ........ | ........ | Do. |
| Do | July 10, 1891 | 10 | 0.26 | 2.6 | ........ | ........ | Do. |
| Do | July 11, 1891 | 9 | 0.29 | 2.5 | ........ | ........ | Do. |
| Do | July 13, 1891 | 2 | 0.33 | 0.6 | ........ | ........ | Do. |
| Do | July 14, 1891 | 1 | 0.41 | 0.3 | ........ | ........ | Do. |
| Do | July 15, 1891 | 1 | 0.49 | 0.3 | ........ | ........ | Do. |
| Alexandria, La | June 13, 1891 | 626 | 1.00 | 542 | *21.91 | 9.4 | Do. |
| Do | June 15, 1891 | 608 | 1.05 | 557 | *21.84 | 9.5 | Do. |
| Do | June 16, 1891 | 617 | 1.00 | 546 | *21.84 | 9.5 | Do. |
| Do | June 17, 1891 | 634 | 1.00 | 568 | *21.98 | 9.3 | Do. |
| Do | June 18, 1891 | 674 | 1.01 | 605 | *22.15 | 9.1 | Do. |
| Do | June 19, 1889 | 700 | 1.03 | 633 | *22.27 | 9.0 | Do. |
| Do | June 20, 1891 | 729 | 1.03 | 674 | *22.42 | 8.9 | Do. |
| Do | June 22, 1891 | 765 | 1.03 | 763 | *22.65 | 8.7 | Do. |
| Do | June 23, 1891 | 803 | 1.06 | 758 | *22.75 | 8.5 | Do. |
| Do | June 24, 1891 | 816 | 1.05 | 763 | *22.83 | 8.5 | Do. |
| Do | June 25, 1891 | 815 | 1.10 | 770 | *22.92 | 8.4 | Do. |
| Do | June 26, 1891 | 828 | 1.09 | 781 | *23.01 | 8.3 | Do. |
| Do | June 27, 1891 | 849 | 1.10 | 785 | *23.04 | 8.3 | Do. |
| Do | June 29, 1891 | 878 | 1.11 | 831 | *23.09 | 8.2 | Do. |
| Do | June 30, 1891 | 852 | 1.08 | 794 | *23.09 | 8.2 | Do. |
| Do | July 1, 1891 | 863 | 1.10 | 795 | *23.09 | 8.2 | Do. |
| Do | July 2, 1891 | 854 | 1.14 | 813 | *23.11 | 8.2 | Do. |
| Do | July 3, 1891 | 852 | 1.10 | 803 | *23.10 | 8.2 | Do. |
| Do | July 4, 1891 | 849 | 1.09 | 809 | *23.04 | 8.3 | Do. |
| Do | July 6, 1891 | 837 | 1.07 | 783 | *23.01 | 8.3 | Do. |
| Do | July 7, 1891 | 876 | 1.07 | 830 | *23.22 | 8.1 | Do. |
| Do | July 8, 1891 | 921 | 1.06 | 848 | *23.47 | 7.8 | Do. |
| Do | July 9, 1891 | 952 | 1.07 | 893 | *23.59 | 7.7 | Do. |
| Do | July 10, 1891 | 961 | 1.07 | 910 | *23.54 | 7.8 | Do. |
| Do | July 11, 1891 | 916 | 1.04 | 832 | *23.30 | 8.0 | Do. |
| Do | July 13, 1891 | 802 | 0.99 | 706 | *22.69 | 8.6 | Do. |
| Do | July 14, 1891 | 799 | 1.01 | 696 | *22.42 | 8.9 | Do. |
| Do | July 15, 1891 | 712 | 0.95 | 631 | *22.22 | 9.1 | Do. |
| Do | July 16, 1891 | 686 | 0.96 | 608 | *22.06 | 9.2 | Do. |
| Do | July 28, 1891 | 457 | 0.86 | 363 | *20.91 | 10.4 | Do. |
| Do | July 29, 1891 | 448 | 0.85 | 346 | *20.81 | 10.5 | Do. |
| Do | July 30, 1891 | 417 | 0.85 | 329 | *20.71 | 10.6 | Do. |
| Do | July 31, 1891 | 396 | 0.87 | 310 | *20.63 | 10.7 | Do. |
| Do | Aug. 1, 1891 | 386 | 0.83 | 294 | *20.54 | 10.8 | Do. |
| Do | Aug. 3, 1891 | 347 | 0.86 | 264 | *20.39 | 10.9 | Do. |
| Do | Aug. 4, 1891 | 330 | 0.83 | 252 | *20.33 | 11.0 | Do. |
| Do | Aug. 5, 1891 | 328 | 0.84 | 244 | *20.28 | 11.0 | Do. |
| Do | Aug. 6, 1891 | 334 | 0.86 | 249 | *20.26 | 11.0 | Do. |
| Do | Aug. 7, 1891 | 337 | 0.84 | 259 | *20.33 | 11.0 | Do. |
| Do | Aug. 8, 1891 | 362 | 0.86 | 288 | *20.47 | 10.8 | Do. |
| Do | Aug. 10, 1891 | 427 | 0.87 | 345 | *20.79 | 10.5 | Do. |
| Do | Aug. 11, 1891 | 458 | 0.91 | 386 | *20.95 | 10.3 | Do. |
| Do | Aug. 12, 1891 | 492 | 0.90 | 409 | *21.00 | 10.3 | Do. |
| Do | Aug. 13, 1891 | 496 | 0.92 | 422 | *21.12 | 10.2 | Do. |
| Do | Aug. 14, 1891 | 521 | 0.92 | 440 | *21.19 | 10.1 | Do. |
| Do | Aug. 15, 1891 | 532 | 0.94 | 452 | *21.24 | 10.1 | Do. |
| Do | Aug. 17, 1891 | 534 | 0.95 | 460 | *21.34 | 10.0 | Do. |
| Do | Aug. 18, 1891 | 549 | 0.98 | 471 | *21.41 | 9.9 | Do. |
| Do | Aug. 19, 1891 | 564 | 0.95 | 483 | *21.44 | 9.9 | Do. |
| Do | Aug. 20, 1891 | 549 | 0.99 | 482 | *21.46 | 9.8 | Do. |
| Do | Aug. 21, 1891 | 546 | 1.00 | 481 | *21.45 | 9.9 | Do. |
| Do | Aug. 22, 1891 | 540 | 0.98 | 462 | *21.43 | 9.9 | Do. |
| Do | Aug. 24, 1891 | 534 | 0.97 | 446 | *21.31 | 10.0 | Do. |
| Do | Aug. 25, 1891 | 521 | 0.91 | 425 | *21.24 | 10.1 | Do. |
| Do | Aug. 26, 1891 | 496 | 0.94 | 415 | *21.18 | 10.1 | Do. |
| Do | Aug. 27, 1891 | 496 | 0.92 | 411 | *21.11 | 10.2 | Do. |
| Do | Aug. 28, 1891 | 497 | 0.91 | 398 | *20.97 | 10.3 | Do. |

* Gauge read at Alexandria.

TABLE 10.—*Discharge observations in Red River, tributaries, and outlets*—Continued.

| Locality. | Date. | Area. | Maximum mid-depth velocities. | Discharge. | Elevation of water surface, Cairo datum. | Stage below maximum high water. | Method. |
|---|---|---|---|---|---|---|---|
| | | *Square meters.* | *Meters.* | *Cubic meters.* | *Meters.* | *Meters.* | |
| Alexandria La | Aug. 29, 1891 | 479 | 0.91 | 385 | *20.88 | 10.4 | Current meter. |
| Do | Aug. 31, 1891 | 449 | 0.89 | 360 | *20.72 | 10.6 | Do. |
| Do | Nov. 17, 1891 | 207 | 0.75 | 119 | 19.13 | 12.2 | Mid-depth floats. |
| Saline Point, 0.5 kilometer below Saline Bayou. | Nov. 21, 1891 | 218 | 0.59 | 108 | 12.20 | 11.3 | Current meter. |
| Do | Nov. 25, 1891 | 356 | 0.82 | 217 | 13.80 | 9.7 | Do. |
| 2.8 kilometers above Lake Latania. | Dec. 2, 1891 | 226 | 0.88 | 153 | 11.60 | 11.9 | Do. |
| Do | Dec. 9, 1891 | 254 | 0.82 | 150 | 11.90 | 11.5 | Do. |
| Little Larto Landing | Dec. 16, 1891 | 296 | 0.80 | 178 | 11.25 | 12.3 | Do. |
| Red River above Black River. | July 18, 1891 | 917 | 0.88 | 677 | 15.02 | 8.4 | Do. |
| Do | July 20, 1891 | 901 | 0.91 | 695 | 14.56 | 8.8 | Do. |
| Do | July 21, 1891 | 886 | 0.95 | 680 | 14.42 | 9.0 | Do. |
| Do | July 22, 1891 | 856 | 0.94 | 645 | 14.22 | 9.2 | Do. |
| Do | July 23, 1891 | 827 | 0.93 | 615 | 14.03 | 9.4 | Do. |
| Do | July 24, 1891 | 797 | 0.92 | 589 | 13.87 | 9.5 | Do. |
| Do | July 25, 1891 | 770 | 0.91 | 583 | 13.67 | 9.7 | Do. |
| Do | July 26, 1891 | 754 | 0.94 | 568 | 13.57 | 9.8 | Do. |
| Black River (tributary) | July 18, 1891 | 1,461 | 0.41 | 529 | 15.08 | 8.3 | Do. |
| Do | July 20, 1891 | 1,410 | 0.42 | 540 | 14.68 | 8.7 | Do. |
| Do | July 21, 1891 | 1,376 | 0.47 | 524 | 14.48 | 8.9 | Do. |
| Do | July 22, 1891 | 1,342 | 0.48 | 516 | 14.30 | 9.1 | Do. |
| Do | July 23, 1891 | 1,309 | 0.44 | 478 | 14.10 | 9.3 | Do. |
| Do | July 24, 1891 | 1,275 | 0.47 | 465 | 13.91 | 9.4 | Do. |
| Do | July 25, 1891 | 1,242 | 0.42 | 446 | 13.74 | 9.7 | Do. |
| Do | July 26, 1891 | 1,226 | 0.44 | 412 | 13.59 | 9.8 | Do. |
| Do | July 27, 1891 | 1,209 | 0.44 | 412 | 13.45 | 10.0 | Do. |
| Red River below Black River. | July 18, 1891 | 1,796 | 0.82 | 1,272 | 14.99 | 8.4 | Do. |
| Do | July 19, 1891 | 1,809 | 0.88 | 1,300 | 14.77 | 8.6 | Do. |
| Do | July 20, 1891 | 1,763 | 0.81 | 1,268 | 14.59 | 8.8 | Do. |
| Do | July 21, 1891 | 1,715 | 0.79 | 1,165 | 14.38 | 9.0 | Do. |
| Do | July 22, 1891 | 1,670 | 0.79 | 1,167 | 14.15 | 9.2 | Do. |
| Do | July 23, 1891 | 1,624 | 0.75 | 1,083 | 13.98 | 9.4 | Do. |
| Do | July 24, 1891 | 1,579 | 0.74 | 1,039 | 13.81 | 9.6 | Do. |
| Do | July 25, 1891 | 1,533 | 0.77 | 1,030 | 13.65 | 9.8 | Do. |
| Red River above Black River. | Dec. 21, 1891 | 393 | 0.58 | 185 | 10.59 | 12.8 | Do. |
| Black River (tributary) | Dec. 21, 1891 | 771 | 0.35 | 222 | 10.59 | 12.8 | Do. |
| 1 kilometer above Seven Mile Bayou. | Dec. 30, 1891 | 1,360 | 0.95 | 1,022 | 12.60 | 10.3 | Do. |
| 2 kilometers above Bayou Cocodrie. | Jan. 6, 1892 | 1,598 | 0.95 | 1,205 | 13.50 | 9.7 | Do. |
| Red River above Cottonwood Bayou. | Nov. 19, 1892 | 582 | 1.11 | 524 | †62.89 | 1.5 | Mid-depth floats. |
| Cottonwood Bayou (outlet). | Nov. 19, 1892 | 156 | 0.87 | 108 | †62.89 | 1.5 | Do. |
| Red River above Twelve Mile Bayou. | May 31, 1892 | 777 | 2.32 | 1,376 | ........ | ........ | Current meter. |
| Do | June 2, 1892 | 768 | 2.29 | 1,305 | ........ | ........ | Do. |
| Do | June 4, 1892 | 751 | 2.27 | 1,209 | ........ | ........ | Do. |
| Twelve Mile Bayou (tributary). | May 31, 1892 | 971 | 1.10 | 720 | ........ | ........ | Do. |
| Do | June 2, 1892 | 950 | 1.26 | 868 | ........ | ........ | Do. |
| Do | June 4, 1892 | 927 | 1.34 | 1,000 | ........ | ........ | Do. |
| Twelve Mile Bayou, overflow, left bank. | May 31, 1892 | 300 | 0.75 | 155 | ........ | ........ | Surface floats. |
| Do | June 2, 1892 | 75 | 0.39 | 21 | ........ | ........ | Do. |
| Twelve Mile Bayou, overflow, right bank. | May 31, 1892 | 820 | 0.94 | 570 | ........ | ........ | Do. |
| Do | June 2, 1892 | 570 | 0.89 | 228 | ........ | ........ | Do. |
| Do | June 4, 1892 | 450 | 0.83 | 167 | ........ | ........ | Do. |
| Twelve Mile Bayou (tributary). | Oct. 19, 1892 | 46 | 0.65 | 24 | 48.73 | 11.5 | Rod floats. |
| Cross Bayou (tributary) | May 30, 1892 | 1,857 | 1.40 | 1,573 | ........ | ........ | Current meter. |
| Do | May 31, 1892 | ........ | ........ | 708 | ........ | ........ | Interpolated. |
| Do | June 1, 1892 | 1,825 | 1.49 | 1,844 | ........ | ........ | Current meter. |
| Do | June 2, 1892 | 1,809 | 1.47 | 1,855 | ........ | ........ | Do. |
| Do | June 3, 1892 | 1,793 | 1.46 | 1,721 | ........ | ........ | Do. |
| Do | June 4, 1892 | 1,777 | 1.49 | 1,753 | ........ | ........ | Do. |
| Cross Bayou, overflow, left bank. | May 31, 1892 | 2,240 | 0.87 | 1,537 | ........ | ........ | Do. |
| Do | June 2, 1892 | 1,770 | 0.95 | 909 | ........ | ........ | Do. |
| Do | June 4, 1892 | 1,600 | 1.02 | 908 | ........ | ........ | Do. |

* Gauge read at Alexandria.

† Gauge read at head of Cottonwood Bayou.

**TABLE 10.**—*Discharge observations in Red River, tributaries, and outlets*—Continued.

| Locality. | Date. | Area. | Maximum mid-depth velocities. | Discharge. | Elevation of water surface, Cairo datum. | Stage below maximum high water. | Method. |
|---|---|---|---|---|---|---|---|
| | | *Square meters.* | *Meters.* | *Cubic meters.* | *Meters.* | *Meters.* | |
| Shreveport, La., below railroad bridge. | May 30, 1892 | 3, 242 | 2. 38 | 6, 442 | *59. 85 | 0. 2 | Current meter. |
| Do | May 31, 1892 | | | 6, 281 | *59. 74 | 0. 3 | Interpolated. |
| Do | June 1, 1892 | 3, 192 | 2. 18 | 6, 120 | *59. 64 | 0. 4 | Current meter. |
| Do | June 2, 1892 | | | 5, 930 | *59. 53 | 0. 5 | Interpolated. |
| Do | June 3, 1892 | 3, 142 | 2. 18 | 5, 741 | *59. 39 | 0. 6 | Current meter. |
| Do | June 4, 1892 | | | 5, 396 | *59. 25 | 0. 8 | Interpolated. |
| Do | June 6, 1892 | 3, 042 | 1. 85 | 4, 705 | *59. 00 | 1. 0 | Current meter. |
| Alexandria, La., below railroad bridge. | June 10, 1892 | 2, 940 | 2. 33 | 5, 405 | 31. 50 | 0. 1 | Do. |
| Do | June 11, 1892 | 2, 940 | 2. 35 | 5, 300 | 31. 50 | 0. 1 | Do. |
| Do | June 13, 1892 | 2, 967 | 2. 30 | 5, 329 | 31. 59 | 0. 0 | Do. |
| Do | June 14, 1892 | 2, 967 | 2. 20 | 5, 105 | 31. 59 | 0. 0 | Do. |
| Do | June 15, 1892 | 2, 940 | 2. 28 | 5, 165 | 31. 50 | 0. 1 | Do. |
| Alexandria, La., overflow, left bank, below railroad bridge. | June 10, 1892 | 76 | 0. 47 | 26 | | | Do. |
| Do | June 11, 1892 | 76 | 0. 34 | 20 | | | Do. |
| Do | June 13, 1892 | 60 | 0. 22 | 6 | | | Do. |
| Do | June 14, 1892 | 48 | 0. 19 | 6 | | | Do. |
| Do | June 15, 1892 | 54 | 0. 37 | 10 | | | Do. |
| Alexandria, La., overflow, right bank, below railroad bridge. | June 10, 1892 | 36 | 1. 23 | 39 | | | Do. |
| Do | June 11, 1892 | 36 | 1. 42 | 44 | | | Do. |
| Do | June 13, 1892 | 39 | 1. 44 | 49 | | | Do. |
| Do | June 14, 1892 | 39 | 1. 09 | 36 | | | Do. |
| Do | June 15, 1892 | 36 | 1. 79 | 48 | | | Do. |
| Alexandria, La., Bayou Phillip (tributary). | June 10, 1892 | 185 | 1. 68 | 253 | | | Do. |
| Do | June 11, 1892 | 185 | 1. 80 | 280 | | | Do. |
| Do | June 13, 1892 | 190 | 1. 86 | 312 | | | Do. |
| Do | June 14, 1892 | 190 | 1. 58 | 253 | | | Do. |
| Do | June 15, 1892 | 185 | 1. 60 | 251 | | | Do. |
| Alexandria, La., Bayou Ranides (tributary). | June 10, 1892 | | | 216 | | | Interpolated. |
| Do | June 11, 1892 | 591 | 0. 51 | 192 | | | Current meter. |
| Do | June 13, 1892 | 607 | 0. 40 | 146 | | | Do. |
| Do | June 14, 1892 | 607 | 0. 32 | 138 | | | Do. |
| Do | June 15, 1892 | 591 | 0. 25 | 122 | | | Do. |
| Fulton, Ark | Dec. 28, 1892 | 1, 219 | 1. 01 | 992 | 81. 54 | 3. 6 | Do. |
| Foot of Jett Island, Ark | Jan. 4, 1893 | 1, 672 | 1. 17 | 1, 530 | 70. 26 | 2. 0 | Do. |
| Upper end of Pearson Place, Ark. | Jan. 9, 1893 | 1, 202 | 1. 17 | 1, 130 | 76. 73 | 1. 8 | Do. |
| Upper end of California Place, Ark. | Jan. 19, 1893 | 960 | 0. 49 | 328 | 70. 79 | 3. 3 | Do. |
| Red River, above Sulphur River. | Jan. 25, 1893 | 885 | 0. 45 | 334 | 69. 43 | 3. 2 | Do. |
| Sulphur River (tributary) | ....do | 378 | 1. 10 | 328 | 69. 43 | 3. 2 | Do. |
| O'Rouke Slough (outlet) | Jan. 30, 1893 | 30 | 0. 44 | 11 | 68. 41 | 2. 5 | Do. |
| Kouns Canal (outlet) | Jan. 31, 1893 | 70 | 0. 57 | 29 | 67. 56 | 3. 2 | Do. |
| Red River, below Kouns Canal. | ....do | 594 | 1. 11 | 484 | 67. 57 | 3. 2 | Do. |
| Hervey Canal (outlet) | Feb. 1, 1893 | 26 | 0. 36 | 7 | 67. 17 | 3. 3 | Do. |
| Posten Bayou (tributary) | Feb. 2, 1893 | 163 | 0. 45 | 57 | 66. 51 | 3. 6 | Do. |
| Near Posten Bayou, in Dutch Jan Lake. | ....do | 102 | 0. 49 | 34 | 66. 50 | 3. 6 | Do. |
| Red Bayou (outlet) | ....do | 126 | 0. 84 | 81 | 66. 35 | 3. 0 | Do. |
| Fuller Inlet (outlet) | Feb. 3, 1893 | 40 | 0. 55 | 18 | 66. 16 | 2. 4 | Do. |
| Fuller Outlet (tributary) | ....do | 94 | 0. 59 | 50 | 65. 62 | 2. 3 | Do. |
| Dooley Bayou (outlet) | ....do | 135 | 0. 89 | 89 | 65. 34 | 2. 2 | Do. |
| Cottonwood Bayou (outlet) | Feb. 6, 1893 | 126 | 0. 73 | 74 | †62. 35 | 2. 0 | Do. |
| Red River, above Twelve Mile Bayou. | Feb. 11, 1893 | 287 | 1. 36 | 268 | *52. 45 | 7. 6 | Do. |
| Twelve Mile Bayou (tributary). | ....do | 350 | 1. 08 | 323 | †52. 45 | 7. 6 | Do. |
| Shreveport, La., below railroad bridge. | ....do | 1, 369 | 0. 60 | 699 | †52. 42 | 7. 6 | Do. |
| Tones Bayou (outlet) | Feb. 15, 1893 | 360 | 0. 32 | 75 | 51. 53 | 5. 2 | Do. |
| Red River, below Tones Bayou. | Feb. 16, 1893 | 748 | 0. 92 | 519 | 51. 48 | 5. 2 | Do. |
| Red River, above Loggy Bayou. | Feb. 21, 1893 | 507 | 1. 50 | 542 | 43. 70 | 7. 1 | Do. |

* Gauge read at Shreveport.

† Gauge read at head of Cottonwood Bayou.

# Red River Survey.

## Precision Rolling Planimeter

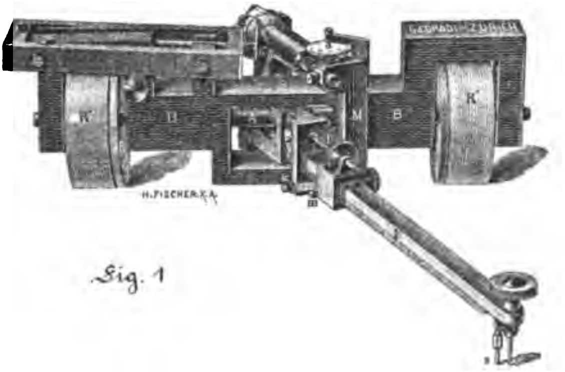

Fig. 1

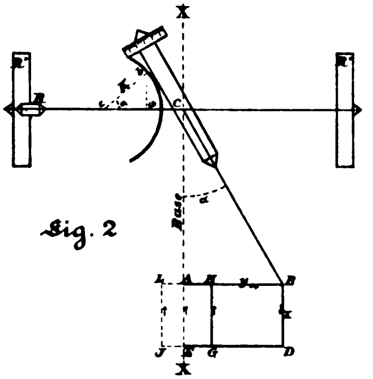

Fig. 2

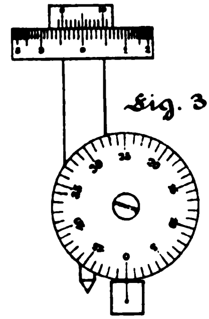

Fig. 3

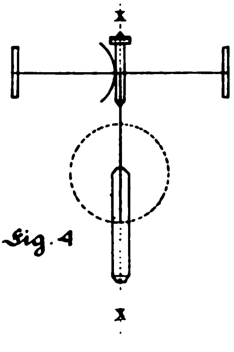

Fig. 4

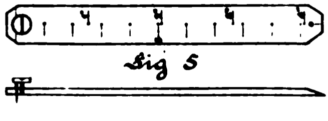

Fig 5

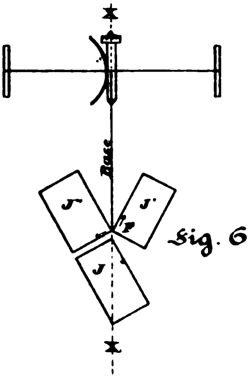

Fig. 6

Photo-Lith. by A. Hoen & Co., Baltimore, Md.

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TABLE 10.—*Discharge observations in Red River, tributaries, and outlets*—Continued.

| Locality. | Date. | Area. | Maximum mid-depth velocities. | Discharge. | Elevation of water surface, Cairo datum. | Stage below maximum high water. | Method. |
|---|---|---|---|---|---|---|---|
| | | *Square meters.* | *Meters.* | *Cubic meters.* | *Meters.* | *Meters.* | |
| Loggy Bayou (tributary) .. | Feb. 12, 1893 | 252 | 0.55 | 110 | 43.70 | 7.1 | Current meter. |
| Bayou Wincey (tributary) . | Feb. 24, 1893 | 314 | 0.35 | 83 | 38.32 | 8.4 | Do. |
| Cane River (outlet) ........ | Feb. 28, 1893 | 44 | 0.68 | 22 | 32.61 | 8.4 | Do. |
| Red River, below Cane River | ....do ....... | 1,014 | 1.29 | 1,086 | 32.60 | 8.4 | Do. |
| Alexandria, La............ | Mar. 7, 1893 | 1,147 | 1.06 | 1,009 | 24.01 | 7.3 | Do. |
| Red River, above Black River. | Mar. 14, 1893 | 1,668 | 0.64 | 843 | 19.06 | 6.3 | Do. |
| Black River (tributary).... | ....do ....... | 2,279 | 0.55 | 1,128 | 19.06 | 6.3 | Do. |

Areas have been measured by an ordinary polar planimeter until January of this year, and since then by the rolling planimeter made by G. Coradi, of Zürich, Switzerland, and imported by you.

Prof. Lorber investigated the accuracy of different kinds of planimeters, and classes the rolling planimeter as an instrument of precision, the error not exceeding 1-1,000 in measuring a small area, or 1-10,000 in a large one. The following description and rules for using the instrument are from a translation by Draftsman Hilleke of the pamphlet sent with it.

The following theory and description may give a clearer understanding of its construction and use, and deserves on account of its brevity and elementary character, to be read by every owner of a rolling planimeter. Those who wish a more exact and elaborate discussion will find it in the excellent essay of Prof. Lorber, of Leoben. (Zeitschrift für Vermessungswesen, Bd. XVII, 1888, Heft 6.)

The mathematical conditions of construction theoretically observed are as follows: (Figs. 1, 2, and 3.) The axis $A$ of the wheels, the segment axis $a$, and the turning axis of the arm $F$ must lie in the same plane and perpendicular to the drawing table, which should be horizontal; and the axis of the measuring cylinder parallel to the arm $F$. The axes of the segment and cylinder should lie in the same horizontal plane, though for practical reasons only. That the segment is exactly spherical, the indicator cylinder true, and the segment, measuring cylinder, and indicator correctly centered are presupposed. The physical requirements are that the segment and cylinder shall move easily but without play, and that the friction of the measuring cylinder in the socket shall be almost nothing. The latter condition is evident, since the effect of the friction will be proportional to the actual forward and backward movement of the measuring cylinder, but not to the area. For instance, the screws might be tightened so as to prevent any movement of the measuring cylinder, no matter how great the area circumscribed. Furthermore, the segment and cylinder must be kept scrupulously clean, as dust or grease alter the contact and vitiate the record; and as the measuring cylinder revolves in both directions with the segment, instead of sliding, as in the Scheiben planimeter, a foreign body will not be removed of itself.

If the instrument is moved forward or back on the map the plane of the turning axis will intersect it in a right line, and if the arm $F$ is set normal to the axis $A$ of the rollers $RR$ the tracer should stand on the line, which we may call the base. In this case the cylinder touches the segment at the pole and, if the instrument is in adjustment, will not revolve when the tracer is moved along the base. If the instrument is at rest and the tracer is moved to right or left small motions of the measuring cylinder will be produced which are equalized in tracing a closed figure and therefore without influence in measuring areas.

To prove the correctness of the principle of construction, it should be shown that in describing $BD$ (Fig. 2) the result of readings on measuring cylinder multiplied by a constant dependent on the instrument is equal to the area of the rectangle $ABDE$, with side $AE$ on the base-line. This area is $AB \times BD = XY$, and if the tracer is moved from $B$ to $D$, that is a distance $X$, so is a point on the roller $R^1$, or of the small wheel $R$, moved over the same distance, while a point $b$ on the segment distant $ab$ from its axis will be moved $X \frac{ab}{R}$ giving a proportional movement to the tangent and measuring cylinder, hence we may write—

$$W = \frac{xab}{R} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

From the similar triangles $ABC$ and $abc$, $\frac{AB}{Bc}=\frac{ab}{bc}$, and making $ab=y$, $CB=F$ = tracer radius, and $bc=K=$ segment radius,

$$W=\frac{K}{FR}(xy) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \qquad (2)$$

in which the coefficient contains the constants of instrument $K$ and $R$, and the constant $F$ for the scale used, which was to be proved.

Making $U$= circumference of the measuring cylinder, $\frac{W}{U}$= unit of graduation, $f$ the unit area $xy$ for the scale, $n$ the number of revolutions, and $J$ the area sought, we have—

$$f=\frac{FRU}{K} \text{ and } J=nf. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \qquad (3)$$

If the tracer is moved along the line $GH$ instead of along the base $EA$ (which does not make the cylinder revolve) so that the area lies to the right of $EA$, the area measured will be $AHGE$; but the motion being retrograde, it is mechanically subtracted from that obtained in tracing over $BD$, leaving a final result on the measuring cylinder proportional to the area actually traced, $BDJH$. Since the result depends upon the difference of readings at starting and returning to the same point, it is immaterial whether the base line lies to the right or left or on the figure; and therefore if the rectangles are assumed to be infinitesimal any figure may be imagined to be made up of such small rectangles and be measured by tracing its outline.

The instrument is packed for shipment with soft tissue paper, the segment covered with a leather cap, and the cylinder frame tied back securely. If received in winter it should not be touched until it has taken the temperature of the room and all condensed moisture has evaporated from the metal; when it may be unpacked and set carefully on the table by taking hold of the tracer and frame $B$. The following rules should be observed:

1. Keep it clean by using the camel's hair brush from time to time, and occasionally wiping cylinder and segment with a soft rag wet with alcohol. Keep the segment covered and the cylinder back from it when not in use, when making adjustments, or when setting the arm $F$. Handle gently at all times, and in tracing move the point slowly and steadily, especially when the contact is near the edge of the segment, as shocks might injure the pivot connections. All revolving parts should turn easily, so that only a slight force should be required to move the instrument.
2. The table should be level and the paper on which are the areas to be traced should be smoothed and fastened with thumb-tacks. If the wheels are liable to be run off the drawing, stretch a piece of the same paper close to or obliquely over it and secure with thumb-tacks.
3. To get the best results set the instrument so that the base line shall pass through or near the center of figure and, preferably, in the general direction of the shorter dimensions; for although the instrument is adjusted to give equal results for equal areas in any position, in practice it is found that the small errors of manipulation will be less and more likely to balance by observing this rule.
4. Begin with the tracer on the point where the base line intersects the outline of the figure, making the cylinder and segment axes perpendicular to each other, because it is only in this position that the error is eliminated or reduced to a minimum; which has its origin in the fact that in circumscribing a figure the tracer is not brought back to the very starting point.
5. Coradi advises against tracing straight lines by a ruler because it may produce a constant error, whereas by tracing free hand the deviations to right and left will be more likely to balance; and these deflections may be kept small by watching the tracer and line carefully.

The instrument is carefully adjusted by the maker, but should be tested from time to time. The arm and wheel axes should turn easily but without play at the pivots. The segment axis should also move freely, and may be allowed a slight play. The segment should be pressed home on the stem to avoid slip. The tangent cylinder should move freely on its pivots with a little play in the direction of its axis; but the cylinder must not touch the vernier and the tally-wheel must not check the motion of the cylinder. All the movements may be adjusted by the steel set-screws which form the pivot sockets, and for this purpose the brass clamp-screws first must be loosened and retightened after adjustment. In general, avoid touching these screws unless convinced that adjustment is really necessary; for if the instrument has been shipped in winter or has been in a cold room, the two axes that revolve most, the segment and the cylinder axes, may bind until the instrument has gained its normal temperature, and, therefore, if the adjustment is made at once, these axes will have too much play after the instrument acquires the temperature of the working room, which would influence the results.

The instrument being apparently in adjustment, take hold of the knob on the tracer arm and see if the parts move freely in shifting to and fro and to right and left. The instrument should roll easily and there should be no shaking in reversing the direction of motion.

To read the results of measurements the arm must be set for the given scale. For example, suppose the drawing is on the scale 1-500: Withdraw the cylinder and cap the segment, and turn the arm to the right; unclamp and slide in or out according to the value given in the table furnished with each instrument. This table is made up of settings on the arm which shall register given areas per vernier unit for given scales. The table also gives the area on the drawing corresponding to area per vernier unit. For small areas the sets for short arm should be used, and the long arm for large areas. Suppose that the setting was 436.2: Slide the arm until the sixth line behind 43 is nearly opposite vernier zero and the second line of vernier covers the eighth line behind 43. Tighten the front clamp and make the setting exact by the slow-motion screws, and then clamp the rear screws. Now place the instrument on the paper so that the arm in its normal position shall be over the assumed base line with the tracer at the center of figure and make a preliminary circuit to see that nothing obstructs the free movement of the planimeter. Mark the intersection of the base line with the perimeter of the figure, put the tracer point exactly on it and circumscribe the figure with a steady motion, returning exactly to the starting point. Record the difference of readings and repeat the operation in the contrary direction, and if the two differences agree very closely take the mean for the result. A preliminary test may be made by tracing rectangles on finely executed section paper. If the drawing has shrunk or stretched by $\frac{1}{m}$, the arm must be shortened or lengthened in the same ratio to give the correct area.

After learning how to handle the planimeter its precision may be tested by observing the following:

1. If the differences recorded by repeated tracings of the same figure vary but slightly.
2. If they remain practically the same in tracing the figure at different distances from the base line.
3. If the "sets for vernier on arm" given in the table are correct.
4. If the constant *C* of the table is correctly given.

Test No. 1 is not absolutely necessary, as the rolling planimeter, contrasted with the common polar planimeter, shows this defect only in a very small degree, and the small variations which may appear between readings are rather chargeable to errors of tracing than to the instrument, if in adjustment, and moreover are of small consequence on account of the small value of area per vernier unit. This test is rather to see if the planimeter is in order and handled properly. The test rule (Figs. 3 and 5) is used for this test. This is a small strip of brass with countersunk points 1 centimeter apart (also graduated to inches), with a center needle-point at zero to be pressed into the paper and a fine line on the bevel at the other end to set on the base or point on the line of beginning. If the tracer is set into one of the countersunk marks and moved from the point of beginning either way around to it again it must trace a circle of known radius. Sideward pressure must be avoided to insure against errors that might be charged improperly to the instrument. For example: In tracing a circle of 6 centimeters radius, a sideward pressure that might cause a variation of only 0.01 millimeter would cause an error in the record of nearly four units, which would be quite appreciable with vernier unit of only 1 square millimeter.

There is a table with the instrument that gives the readings for the most common ratios and vernier units corresponding to circles of 1 centimeter to 10 centimeters radius, but it must not be expected that the readings shall agree absolutely with the tabulated areas, since faultless manipulation is not possible, but that the variations shall be minute. The test-rule is also used for test No. 2, as follows: Put the center point on the base line so that the latter shall be a diameter, and afterward to the right or left of the base line so that the circle shall be to the right or left of it, or at least the greater part, and describe the circles several times and see if the differences are essentially the same in all the sets, remembering, however, always to begin on the base line or as near as possible to it, and to return exactly to the starting points. Are the readings in circumscribing the figure to the left of the base line greater than those to to the right, shift the end of the cylinder nearest the tracer to the left so as to make it parallel to the arm; and conversely if the readings in tracing the circle to the right of the base line are the greater. This correction is made by means of two opposing set-screws that hold the plate in which the cylinder front pivot-screw works. Besides testing with the test-rule it will be well to try plotted rectangular figures before determining to alter the adjustment. Figure 6 shows favorable positions for the circles or rectangles.

Test No. 3 may be made on plotted rectangles or with the test-rule in different points, giving circles of various radii, with arm set by the table, and comparing the readings multiplied by the vernier unit with the calculated areas. Are the readings too small by the *nth* part of the area the arm must be shortened by the *nth* part of its length and conversely. To find, without trial, settings not given in the table, there are given values of $a_o$ of the vernier unit for the scale 1: 1 in square millimeters; that is, the square millimeter on the plan corresponding to one vernier unit. For example: If $L$ is the longest and $L_1$ the shortest setting on the arm in the table, and $a$ and $a_1$ the corresponding values of vernier unit, if $L_2$ is wanted as the set corresponding to a vernier unit $a_2$, let $X$ = length of arm for value $a-a_2$ and we have

$$\frac{L-L_1}{X}=\frac{a-a_1}{a-a_2}.$$

$$X=\frac{(L-L_1)\ (a-a_2)}{a-a_1} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (4)$$

$$L_2=L-X. \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (5)$$

Suppose $L=608.1$, $a=2$ square millimeters (corresponding to 2 square meters on scale of 1-1000), $L_1=242.5$, $a_1=0.8$ square millimeter (corresponding to 2 square meters on scale of 1-500), wanted to set $L_2$ for scale 1-3000, with vernier unit corresponding to 10 square meters, $a_2=\frac{10}{9}$ square millimeters.

$$X=\frac{(608.1-242.5)\ (2-\frac{10}{9})}{2-0.8}=\frac{365.6\times\frac{8}{9}}{1.2}=270.8$$

$$L_2=608.1-270.8=337.3$$

To calculate in square millimeters (or in square inches) the value of vernier unit as $a_2$ on the drawing for any ratio as $\frac{1}{s}$, the vernier unit of area $A$ given for $\frac{1}{s}$ must be divided by $S^2$. For example: we wish the area in square millimeters on a scale 1-3000 which corresponds to 10 square meters per vernier unit.

$$\frac{10\text{ sq. meters}}{3000^2}=\frac{10^7}{9\times10^6}=\frac{10}{9}=1\tfrac{1}{9}\text{ square millimeters.}$$

This calculated setting also should be tested by tracing known rectangles or circles.

Test No. 4 for the constant may be made best by tracing a known rectangle from right around to left, in reverse to the movement of watch hands, subtract the first reading from the quotient of the known area divided by the vernier unit and add the second reading to the remainder and the sum should be equal to the constant.

*Conversion table; meters to feet.*

| Meters. | 0.0 | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 | 0.9 |
|---|---|---|---|---|---|---|---|---|---|---|
| 10 | 32.8 | 33.1 | 33.4 | 33.8 | 34.1 | 34.4 | 34.8 | 35.1 | 35.4 | 35.8 |
| 11 | 36.1 | 36.4 | 36.7 | 37.1 | 37.4 | 37.7 | 38.0 | 38.4 | 38.7 | 39.1 |
| 12 | 39.4 | 30.7 | 40.0 | 40.4 | 40.7 | 41.0 | 41.4 | 41.7 | 42.0 | 42.3 |
| 13 | 42.6 | 42.9 | 43.2 | 43.6 | 43.9 | 44.2 | 44.6 | 44.9 | 45.2 | 45.6 |
| 14 | 45.9 | 46.2 | 46.5 | 46.9 | 47.2 | 47.5 | 47.9 | 48.2 | 48.5 | 48.9 |
| 15 | 49.2 | 49.5 | 49.8 | 50.2 | 50.5 | 50.8 | 51.2 | 51.5 | 51.8 | 52.2 |
| 16 | 52.5 | 52.8 | 53.1 | 53.5 | 53.8 | 54.1 | 54.5 | 54.8 | 55.1 | 55.5 |
| 17 | 55.8 | 56.1 | 50.4 | 56.8 | 57.1 | 57.4 | 57.8 | 58.1 | 58.4 | 58.7 |
| 18 | 59.0 | 59.3 | 59.6 | 60.0 | 60.3 | 60.6 | 61.0 | 61.3 | 61.6 | 62.0 |
| 19 | 62.3 | 62.6 | 62.9 | 63.3 | 63.6 | 63.9 | 64.3 | 64.6 | 64.9 | 65.3 |
| 20 | 65.6 | 65.9 | 66.2 | 66.6 | 66.9 | 67.2 | 67.6 | 67.9 | 68.2 | 68.6 |
| 21 | 68.9 | 69.2 | 69.5 | 69.9 | 70.2 | 70.5 | 70.9 | 71.2 | 71.5 | 71.9 |
| 22 | 72.2 | 72.5 | 72.8 | 73.2 | 73.5 | 73.8 | 74.2 | 74.5 | 74.8 | 75.2 |
| 23 | 75.5 | 75.8 | 76.1 | 76.5 | 76.8 | 77.1 | 77.5 | 77.8 | 78.1 | 78.4 |
| 24 | 78.7 | 79.0 | 79.3 | 79.7 | 80.0 | 80.3 | 80.7 | 81.0 | 81.3 | 81.7 |
| 25 | 82.0 | 82.3 | 82.6 | 83.0 | 83.3 | 83.6 | 84.0 | 84.3 | 84.6 | 85.0 |
| 26 | 85.3 | 85.6 | 85.9 | 86.3 | 86.6 | 86.9 | 87.3 | 87.6 | 87.9 | 88.3 |
| 27 | 88.6 | 88.9 | 89.2 | 89.6 | 89.9 | 90.2 | 90.6 | 90.9 | 91.2 | 91.6 |
| 28 | 91.9 | 92.2 | 92.5 | 92.9 | 93.2 | 93.5 | 93.9 | 94.2 | 94.5 | 94.8 |
| 29 | 95.1 | 95.4 | 95.7 | 96.1 | 96.4 | 96.7 | 97.1 | 97.4 | 97.7 | 98.1 |
| 30 | 98.4 | 98.7 | 99.0 | 99.4 | 99.7 | 100.0 | 100.4 | 100.7 | 101.0 | 101.4 |
| 31 | 101.7 | 102.0 | 102.3 | 102.7 | 103.0 | 103.3 | 103.7 | 104.0 | 104.3 | 104.7 |
| 32 | 105.0 | 105.3 | 105.6 | 106.0 | 106.3 | 106.6 | 107.0 | 107.3 | 107.6 | 108.0 |
| 33 | 108.3 | 108.6 | 108.9 | 109.3 | 109.6 | 109.9 | 110.3 | 110.6 | 110.9 | 111.3 |
| 34 | 111.6 | 111.9 | 112.2 | 112.6 | 112.9 | 113.2 | 113.6 | 113.9 | 114.2 | 114.5 |
| 35 | 114.8 | 115.1 | 115.4 | 115.8 | 116.1 | 116.4 | 116.8 | 117.1 | 117.4 | 117.8 |
| 36 | 118.1 | 118.4 | 118.7 | 119.1 | 119.4 | 119,7 | 120.1 | 120.4 | 120.7 | 121.1 |

*Conversion table; meters to feet*—Continued.

| Meters. | 0.0 | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 | 0.9 |
|---|---|---|---|---|---|---|---|---|---|---|
| 37 | 121.4 | 121.7 | 122.0 | 122.4 | 122.7 | 123.0 | 123.4 | 123.7 | 124.0 | 124.4 |
| 38 | 124.7 | 125.0 | 125.3 | 125.7 | 126.0 | 126.3 | 126.7 | 127.0 | 127.3 | 127.7 |
| 39 | 128.0 | 128.3 | 128.6 | 129.0 | 129.3 | 129.6 | 130.0 | 130.3 | 130.6 | 130.9 |
| 40 | 131.2 | 131.5 | 131.8 | 132.2 | 132.5 | 132.8 | 133.2 | 133.5 | 133.8 | 134.2 |
| 41 | 134.5 | 134.8 | 135.1 | 135.5 | 135.8 | 136.1 | 136.5 | 136.8 | 137.1 | 137.5 |
| 42 | 137.8 | 138.1 | 138.4 | 138.8 | 139.1 | 139.4 | 139.8 | 140.1 | 140.4 | 140.8 |
| 43 | 141.1 | 141.4 | 141.7 | 142.1 | 142.4 | 142.7 | 143.1 | 143.4 | 143.7 | 144.1 |
| 44 | 144.4 | 144.7 | 145.0 | 145.4 | 145.7 | 146.0 | 146.4 | 146.7 | 147.0 | 147.4 |
| 45 | 147.6 | 147.9 | 148.2 | 148.6 | 148.9 | 149.2 | 149.6 | 149.9 | 150.2 | 150.6 |
| 46 | 150.9 | 151.2 | 151.5 | 151.9 | 152.2 | 152.5 | 152.9 | 153.2 | 153.5 | 153.9 |
| 47 | 154.2 | 154.5 | 154.8 | 155.2 | 155.5 | 155.8 | 156.2 | 156.5 | 156.8 | 157.2 |
| 48 | 157.5 | 157.8 | 158.1 | 158.5 | 158.8 | 159.1 | 159.5 | 159.8 | 160.1 | 160.5 |
| 49 | 160.8 | 161.1 | 161.4 | 161.8 | 162.1 | 162.4 | 162.8 | 163.1 | 163.4 | 163.8 |
| 50 | 164.0 | 164.3 | 164.6 | 165.0 | 165.3 | 165.6 | 166.0 | 166.3 | 166.6 | 167.0 |
| 51 | 167.3 | 167.6 | 167.9 | 168.3 | 168.6 | 168.9 | 169.3 | 169.6 | 169.9 | 170.3 |
| 52 | 170.6 | 170.9 | 171.2 | 171.6 | 171.9 | 172.2 | 172.6 | 172.9 | 173.2 | 173.6 |
| 53 | 173.9 | 174.2 | 174.5 | 174.9 | 175.2 | 175.5 | 175.9 | 176.2 | 176.5 | 176.9 |
| 54 | 177.2 | 177.5 | 177.8 | 178.2 | 178.5 | 178.8 | 179.2 | 179.5 | 179.8 | 180.2 |
| 55 | 180.4 | 180.7 | 181.0 | 181.4 | 181.7 | 182.0 | 182.4 | 182.7 | 183.0 | 183.4 |
| 56 | 183.7 | 184.0 | 184.3 | 184.7 | 185.0 | 185.3 | 185.7 | 186.0 | 186.3 | 186.7 |
| 57 | 187.0 | 187.3 | 187.6 | 188.0 | 188.3 | 188.6 | 189.0 | 189.3 | 189.6 | 190.0 |
| 58 | 190.3 | 190.6 | 190.9 | 191.3 | 191.6 | 191.9 | 192.3 | 192.6 | 192.9 | 193.3 |
| 59 | 193.6 | 193.9 | 194.2 | 194.6 | 194.9 | 195.2 | 195.6 | 195.9 | 196.2 | 196.6 |
| 60 | 196.8 | 197.1 | 197.4 | 197.8 | 198.1 | 198.4 | 198.8 | 199.1 | 199.4 | 199.8 |
| 61 | 200.1 | 200.4 | 200.7 | 201.1 | 201.4 | 201.7 | 202.1 | 202.4 | 202.7 | 203.1 |
| 62 | 203.4 | 203.7 | 204.0 | 204.4 | 204.7 | 205.0 | 205.4 | 205.7 | 206.0 | 206.4 |
| 63 | 206.7 | 207.0 | 207.3 | 207.7 | 208.0 | 208.3 | 208.7 | 209.0 | 209.3 | 209.7 |
| 64 | 210.0 | 210.3 | 210.6 | 211.0 | 211.3 | 211.6 | 212.0 | 212.3 | 212.6 | 213.0 |
| 65 | 213.2 | 213.5 | 213.8 | 214.2 | 214.5 | 214.8 | 215.2 | 215.5 | 215.8 | 216.2 |
| 66 | 216.5 | 216.8 | 217.1 | 217.5 | 217.8 | 218.1 | 218.5 | 218.8 | 219.1 | 219.5 |
| 67 | 219.8 | 220.1 | 220.4 | 220.8 | 221.1 | 221.4 | 221.8 | 222.1 | 222.4 | 222.8 |
| 68 | 223.1 | 223.4 | 223.7 | 224.1 | 224.4 | 224.7 | 225.1 | 225.4 | 225.7 | 226.1 |
| 69 | 226.4 | 226.7 | 227.0 | 227.4 | 227.7 | 228.0 | 228.4 | 228.7 | 229.0 | 229.4 |
| 70 | 229.6 | 229.9 | 230.2 | 230.6 | 230.9 | 231.2 | 231.6 | 231.9 | 232.2 | 232.6 |
| 71 | 232.9 | 233.2 | 233.5 | 233.9 | 234.2 | 234.5 | 234.9 | 235.2 | 235.5 | 235.9 |
| 72 | 236.2 | 236.5 | 236.8 | 237.2 | 237.5 | 237.8 | 238.2 | 238.5 | 238.8 | 239.2 |
| 73 | 239.5 | 239.8 | 240.1 | 240.5 | 240.8 | 241.1 | 241.5 | 241.8 | 242.1 | 242.5 |
| 74 | 242.8 | 243.1 | 243.4 | 243.8 | 244.1 | 244.4 | 244.8 | 245.1 | 245.4 | 245.8 |
| 75 | 246.1 | 246.4 | 246.7 | 247.1 | 247.4 | 247.7 | 248.1 | 248.4 | 248.7 | 249.1 |
| 76 | 249.3 | 249.6 | 249.9 | 250.3 | 250.6 | 250.9 | 251.3 | 251.6 | 251.9 | 252.3 |
| 77 | 252.6 | 252.9 | 253.2 | 253.6 | 253.9 | 254.2 | 254.6 | 254.9 | 255.2 | 255.6 |
| 78 | 255.9 | 256.2 | 256.5 | 256.9 | 257.2 | 257.5 | 257.9 | 258.2 | 258.5 | 258.9 |
| 79 | 259.2 | 259.5 | 259.8 | 260.2 | 260.5 | 260.8 | 261.2 | 261.5 | 261.8 | 262.2 |
| 80 | 262.5 | 262.8 | 263.1 | 263.5 | 263.8 | 264.1 | 264.5 | 264.8 | 265.1 | 265.5 |
| 81 | 265.7 | 266.0 | 266.3 | 266.7 | 267.0 | 267.3 | 267.7 | 268.0 | 268.3 | 268.7 |
| 82 | 269.0 | 269.3 | 269.6 | 270.0 | 270.3 | 270.6 | 271.0 | 271.3 | 271.6 | 272.0 |
| 83 | 272.3 | 272.6 | 272.9 | 273.3 | 273.6 | 273.9 | 274.3 | 274.6 | 274.9 | 275.3 |
| 84 | 275.6 | 275.9 | 276.2 | 276.6 | 276.9 | 277.2 | 277.6 | 277.9 | 278.2 | 278.6 |
| 85 | 278.9 | 279.2 | 279.5 | 279.9 | 280.2 | 280.5 | 280.9 | 281.2 | 281.5 | 281.9 |
| 86 | 282.2 | 282.5 | 282.8 | 283.2 | 283.5 | 283.8 | 284.2 | 284.5 | 284.8 | 285.2 |
| 87 | 285.4 | 285.7 | 286.0 | 286.4 | 286.7 | 287.0 | 287.4 | 287.7 | 288.0 | 288.4 |
| 88 | 288.7 | 289.0 | 289.3 | 289.7 | 290.0 | 290.3 | 290.7 | 291.0 | 291.3 | 291.7 |
| 89 | 292.0 | 292.3 | 292.6 | 293.0 | 293.3 | 293.6 | 294.0 | 294.3 | 294.6 | 295.0 |
| 90 | 295.3 | 295.6 | 295.9 | 296.3 | 296.6 | 296.9 | 297.3 | 297.6 | 297.9 | 298.3 |
| 91 | 298.6 | 298.9 | 299.2 | 299.6 | 299.9 | 300.2 | 300.6 | 300.9 | 301.2 | 301.6 |
| 92 | 301.8 | 302.1 | 302.4 | 302.8 | 303.1 | 303.4 | 303.8 | 304.1 | 304.4 | 304.8 |
| 93 | 305.1 | 305.4 | 305.7 | 306.1 | 306.4 | 306.7 | 307.1 | 307.4 | 307.7 | 308.1 |
| 94 | 308.4 | 308.7 | 309.0 | 309.4 | 309.7 | 310.0 | 310.4 | 310.7 | 311.0 | 311.4 |
| 95 | 311.7 | 312.0 | 312.3 | 312.7 | 313.0 | 313.3 | 313.7 | 314.0 | 314.3 | 314.7 |
| 96 | 315.0 | 315.3 | 315.6 | 316.0 | 316.3 | 316.6 | 317.0 | 317.3 | 317.6 | 318.0 |
| 97 | 318.2 | 318.5 | 318.8 | 319.2 | 319.5 | 319.8 | 320.2 | 320.5 | 320.8 | 321.2 |
| 98 | 321.5 | 321.8 | 322.1 | 322.5 | 322.8 | 323.1 | 323.5 | 323.8 | 324.1 | 324.5 |
| 99 | 324.8 | 325.1 | 325.4 | 325.8 | 326.1 | 326.4 | 326.8 | 327.1 | 327.4 | 327.8 |
| 100 | 328.1 | 328.4 | 328.7 | 329.1 | 329.4 | 329.7 | 330.1 | 330.4 | 330.7 | 331.1 |

The U. S. Coast and Geodetic Survey (office of standard weights and measures) bulletin dated November, 1891, gives: Log. 1 meter = 0.5159842 = 3.280833 feet. (See also Appendix No. 18, U. S. Coast and Geodetic Survey, Annual Report, 1890.)

Very respectfully, your obedient servant,

H. M. MARSHALL,
*Assistant Engineer.*

Capt. J. H. WILLARD,
*Corps of Engineers.*

### DETAILED ESTIMATES.

| | | |
|---|---|---|
| ***Plant.*** | | |
| Hercules dredge | $30,000 | |
| Steel tow and dispatch steamboat | 16,000 | |
| Pile-driver with steam hammer | 4,000 | |
| Quarter boats and barges | 10,000 | |
| Outfit, tools, rigging, etc | 5,000 | |
| | | $65,000 |
| ***Service of plant.*** | | |
| Expenses of snag and tow boats | 30,000 | |
| Expenses of dredges | 20,000 | |
| Expenses of shore and chopping parties | 12,000 | |
| | | 62,000 |
| ***Care of plant.*** | | |
| Special repairs, steel bottom for snag boat | 10,000 | |
| Regular and extraordinary repairs | 5,000 | |
| Wages, subsistence, and supplies for fleet | 4,000 | |
| | | 19,000 |
| ***Construction.*** | | |
| New levees and extending and enlarging State levees by joining with State engineers and levee boards for the purpose of confining the waters of Red River to the prescribed channel, thereby giving ease and safety to navigation, 2,250,000 cubic yards, more or less | 450,000 | |
| Continuing gradual closing of outlets, and draining impounded water from Choctaw Bayou, 200,000 cubic yards, more or less | 50,000 | |
| Beginning sill in Tones Bayou | 25,000 | |
| Dikes and revetment at Shreveport | 50,000 | |
| Dikes and revetment at Alexandria | 30,000 | |
| Continuing the removal of rock at the Falls of Alexandria | 15,000 | |
| | | 620,000 |
| ***Surveys.*** | | |
| Completing Red River survey, maps, etc | 16,000 | |
| Local surveys and examinations | 3,000 | |
| Establishing new gauges, leveling, monuments, and discharge observations | 6,000 | |
| | | 25,000 |
| ***Administration.*** | | |
| Expenses of office, rent, stationery, etc | 4,000 | |
| Assistant engineers, draftsmen, inspection, mileage, transportation, and contingencies | 5,000 | |
| | | 9,000 |
| | | 800,000 |

## *Money statement.*

| | | |
|---|---|---|
| July 1, 1892, balance unexpended | | $42,693.13 |
| Amount appropriated by act approved July 13, 1892 | | 145,000.00 |
| Received from sales of property to other work | | 13.83 |
| | | 187,706.96 |
| June 30, 1893, amount expended during fiscal year | | 90,634.92 |
| July 1, 1893, balance unexpended | | 97,072.04 |
| July 1, 1893, outstanding liabilities | $1,676.32 | |
| July 1, 1893, amount covered by uncompleted contracts | 4,979.30 | |
| | | 6,655.62 |
| July 1, 1893, balance available | | 90,416.42 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895 } Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893. | | 800,000.00 |

The amounts expended during the fiscal year ending June 30, 1893, and balances unexpended July 1, 1893, are as follows:

| | Expended during year. | Balances July 1, 1893. |
|---|---|---|
| For general improvement, repairs, care of plant, etc | $21,486.25 | $51,213.24 |
| For work at Alexandria, La | 12,617.61 | 1,928.39 |
| For Little River, from Scopini Cut-off to Knox Point | 1,147.68 | 15,882.93 |
| For Sale and Murphy Outlet | 8.88 | ............ |
| For Cypress Bayou, etc | 59.45 | 4,981.50 |
| For survey of Red River | 12,872.59 | 8,233.44 |
| For construction of levees | 42,442.46 | 14,832.54 |
| Total | 90,634.92 | 97,072.04 |

COMMERCIAL STATISTICS.

During the entire fiscal year Red River was navigable from Shreveport to the mouth. The mouth was reported closed to navigation from October 1 to November 16, 1892. From Shreveport to Fulton the river was navigable for seven months and the smaller boats could run the year round.

*List of steamboats engaged in the trade during the fiscal year.*

| Names of steamboats. | Class. | Tonnage. | Length. | Breadth. | Depth. | Draft. | | Between— | Round trips. | Passengers. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Light. | Loaded. | | | |
| | | | *Feet.* | *Feet.* | *Feet.* | *Ft. in.* | *Ft. in.* | | | |
| Valley Queen | Stern-wheel. | 410.83 | 190.6 | 35.8 | 5.6 | 3 0 | 8 0 | New Orleans and Shreveport, La. | 20 | 2,013 |
| | | | | | | | | New Orleans and Cedar Bluff, La. | 1 | ...... |
| Garland | ..do | 261.42 | 162.0 | 30.0 | 4.8 | 2 0 | 5 0 | New Orleans and Coushatta, La. | 2 | 22 |
| Hallette | ..do | 265.90 | 161.0 | 30.5 | 4.5 | 2 0 | 5 0 | New Orleans and Shreveport, La. | 27 | 1,096 |
| | | | | | | | | New Orleans and Coushatta La. | 1 | ...... |
| C. E. Satterlee | ..do | 254.49 | 162.0 | 30.0 | 4.5 | 2 0 | 5 0 | New Orleans and Shreveport, La. | 12 | 67 |
| Friendly | ..do | 66.76 | 120.0 | 26.0 | 3.3 | 0 11 | 3 0 | Not reported. | .... | ...... |
| Rosa Bland | ..do | 148.71 | 113.2 | 22.8 | 4.4 | 1 3 | 3 6 | Shreveport and Garland, Ark. | 16 | 97 |
| | | | | | | | | Shreveport and Coushatta, La. | 7 | 38 |
| | | | | | | | | Shreveport and Jefferson, Tex. | 14 | 61 |
| Blue Wing | ..do | 111.82 | 119.0 | 24.0 | 4.2 | 1 8 | 3 6 | Not reported. | .... | ...... |
| E. B. Wheelock | ..do | 254.49 | 160.0 | 30.0 | 4.9 | 1 8 | 5 6 | New Orleans and Shreveport, La. | 19 | 850 |
| Nat. F. Dortch | ..do | 302.88 | 164.0 | 28.8 | 3.5 | 1 3 | 3 6 | Shreveport and Alexandria, La. | 26 | 183 |
| | | | | | | | | Shreveport and Garland, Ark. | 7 | 89 |
| | | | | | | | | Shreveport and Gilmer, La. | 6 | 31 |
| | | | | | | | | Shreveport and Coushattta, La. | 4 | 36 |
| | | | | | | | | Shreveport and New Orleans, La. | 1 | ...... |
| | | | | | | | | Shreveport and Jefferson, Tex. | 13 | 55 |
| Jim Watson | ..do | 79.61 | 109.0 | 28.0 | 3.4 | ...... | ...... | Not reported. | .... | ...... |
| Dacotah | ..do | 956.98 | 252.0 | 48.3 | 5.5 | ...... | ...... | New Orleans and Coushatta, La. | 2 | ...... |
| | | | | | | | | New Orleans and Pecan Point, La. | 2 | ...... |
| Ida B. Cothell | ..do | 57.05 | 92.7 | 22.1 | 3.7 | ...... | ...... | New Orleans and Black River, La. | 1 | ...... |
| Will. H. Woods | Tug | 22.34 | 72.2 | 16.0 | 7.6 | ...... | ...... | Towing timber. | .... | ...... |

*Summary of commerce reported.*

| Article. | 1892–'93. | 1891–'92. | 1890–'91. | 1889–'90. | 1888–'89. |
|---|---|---|---|---|---|
| | *Tons.* | *Tons.* | *Tons.* | *Tons.* | *Tons.* |
| Cotton | 14, 061 | 29, 400 | 21, 613 | 18, 838 | 12, 593 |
| Cotton seed | 7, 902 | 31, 832 | 12, 249 | 14, 140 | 11, 975 |
| Cotton-seed meal | 4, 713 | .......... | 10, 000 | .......... | .......... |
| Live stock | 1, 185 | 286 | 38 | .......... | 32 |
| Hides and skins | 62 | 151 | 212 | 35 | 97 |
| Lumber | 1, 520 | 2, 352 | .......... | 4, 519 | .......... |
| Saw logs | 15, 200 | 22, 250 | 16, 523 | .......... | .......... |
| Staves | 1, 739 | 206 | 81 | 58 | .......... |
| Stone | .......... | .......... | .......... | .......... | 4, 600 |
| Miscellaneous | 5, 964 | 14, 107 | 2, 719 | 136 | 373 |
| Total down freight | 52, 346 | 100, 584 | 63, 435 | 37, 726 | 29, 670 |
| Return freight | 17, 605 | 19, 942 | 30, 051 | 28, 650 | 19, 780 |
| Total | 69, 951 | 120, 526 | 93, 486 | 66, 376 | 49, 450 |
| Estimated value | $3, 422, 000 | $6, 877, 000 | $9, 185, 000 | $6, 820, 000 | $5, 370, 000 |

In addition to the above, from Ouachita River, entering Red River at mouth of Black River, 88,441 tons, the value of which is estimated to be $4,466,000.

The reduced tonnage of the past fiscal year was due to the unprecedented flood of 1892, which caused a short crop throughout the entire Red River Valley.

The following table shows receipts and shipments of cotton at Shreveport, La.:

| | 1892–'93. | 1891–'92. | 1890–'91. | 1889–'90. | 1888–'89. |
|---|---|---|---|---|---|
| *Receipts.* | *Bales.* | *Bales.* | *Bales.* | *Bales.* | *Bales.* |
| By rail | 25, 277 | 44, 256 | 39, 890 | 25, 476 | 30, 331 |
| By wagon | 31, 612 | 49, 644 | 37, 725 | 40, 026 | 35, 450 |
| By river | 4, 821 | 9, 189 | 14, 836 | 8, 897 | 12, 368 |
| Warehouse receipts | 61, 710 | 103, 089 | 92, 449 | 74, 399 | 78, 149 |
| *Shipments.* | | | | | |
| By Texas and Pacific R. R | 26, 904 | 36, 645 | 23, 311 | 23, 690 | 20, 582 |
| By Vicksburg, Shreveport and Pacific R. R | 10, 384 | 23, 251 | 15, 564 | 20, 813 | 24, 029 |
| By Shreveport and Houston R. R | 3, 114 | 5, 353 | 13, 860 | 12, 529 | 494 |
| By St. Louis Southwestern R. R | 7, 818 | 24, 187 | 15, 039 | 8, 820 | 24, 125 |
| By river to New Orleans | 14, 751 | 10, 567 | 19, 218 | 8, 412 | 8, 956 |
| Total | 62, 971 | 100, 003 | 86, 992 | 74, 264 | 78, 184 |

The water route from Shreveport, La., to Jefferson, Tex., through the lakes and Cypress Bayou, was navigable from November 24 to June 30. The number of trips made by steamboats is included in the foregoing list, and the freights reported were as follows:

| Article. | 1892–'93. | 1891–'92. | 1890–'91. | 1889–'90. |
|---|---|---|---|---|
| | *Tons.* | *Tons.* | *Tons.* | *Tons.* |
| Cotton | 1, 115 | 467 | 625 | 200 |
| Cotton seed | 105 | 60 | 200 | 25 |
| Hides and skins | 6 | 75 | .......... | .......... |
| Live stock | 4 | 14 | .......... | .......... |
| Lumber | 44 | .......... | .......... | .......... |
| Saw logs | 62, 100 | 60, 075 | 82, 400 | (*) |
| Shingles | 2, 000 | .......... | .......... | .......... |
| Miscellaneous | 45 | 990 | 1, 825 | .......... |
| Total down freight | 65, 419 | 61, 591 | 85, 050 | 225 |
| Return freight | 732 | 272 | 700 | 3, 300 |
| Total | 66, 151 | 61, 863 | 85, 750 | 3, 525 |
| Estimated value | $535, 000 | $344, 000 | $748, 000 | $304, 325 |

* Not reported.

The competing routes of transportation for the trade of Red River Valley below Fulton, Ark., are as follows: The river is crossed by the St. Louis, Iron Mountain and Southern Railway at Fulton, Ark., by the St. Louis Southwestern Railway (Cotton Belt Route) at Garland, Ark., and by the Vicksburg, Shreveport and Pacific Railroad at Shreveport, La., and a branch of the Cotton Belt system from Lewisville, Ark., 8 miles east of Garland, runs parallel to the river to Shreveport. The Texas and Pacific Railway runs nearly parallel to the river, and touches at Alexandria, Royce, Shreveport and other points on the main river, and at Jefferson, Tex., on Cypress Bayou, and connects at Texarkana, Ark., with the Cotton Belt and St. Louis, Iron Mountain and Southern. Morgan's Louisiana and Texas Railroad, a branch of the Southern Pacific, runs from Alexandria to the main line. Shreveport is the eastern terminus of the Shreveport and Houston Railroad. The Houston, Central Arkansas and Northern Railroad, a branch of the Missouri Pacific system, crosses the river about 1¼ miles above Alexandria. The Kansas City, Watkins and Gulf Railway runs from Lake Charles, La., on the Southern Pacific, to Alexandria, and another line is projected that will cross at Alexandria. Jefferson, Tex., at the head of navigation of Cypress Bayou, has transportation by the Missouri, Kansas and Texas Railway, in addition to the Texas and Pacific Railway mentioned above. The Kansas City and New Orleans Railway is projected to run about 100 miles, from Kuli Juli, Ind. T., to Collins Bluff, Ark., on Red River, 80 miles above Shreveport. The Texarkana and Shreveport Railroad is built from Texarkana to Lynn, Ark., about 6 miles above mouth of Sulphur River. The extension of the Texarkana and Fort Smith Railway, projected from Kansas City, Mo., to Sabine Pass, Tex., will touch Red River at Shreveport, La. An extension of the Sherman, Shreveport and Southern Railway is projected to run from Jefferson to Shreveport, about 50 miles, or from Jefferson to Waskom, Tex., about 30 miles.

## V 2.

### IMPROVEMENT OF RED RIVER ABOVE FULTON, ARK.

An examination of Red River above Fulton, Ark., was made in 1884, in accordance with requirements of river and harbor act of that year, and the plan recommended for its improvement contemplated removal of snags and drifts, etc., to secure safer high water navigation from Fulton up to the mouth of Kiamichi River, Indian Territory. (Report Chief of Engineers, 1885, pp. 1617–1627.) The distance from Fulton to Kiamichi River by river is about 138 miles. The estimated cost of the work was $10,000, if expended in one season's operations. In 1889 an additional appropriation of $2,000 was recommended, to be applied to going over and completing the work. In 1891 it was recommended that no further work be done, unless a single appropriation of not less than $10,000 be granted, to allow the systematic clearing of the banks and removal of logs from the channel.

The appropriations have been as follows:

| By act of— | |
|---|---|
| August 5, 1886 | $7,000 |
| August 11, 1888 | 3,000 |
| September 19, 1890 | 2,000 |
| July 13, 1892 | 3,500 |
| Total amount appropriated | 15,500 |

In the fiscal year 1887 the hand-propelled snag boat *Harry Breck*, fitted with steam capstan, was built at Fulton at a cost of $4,000, for use on this improvement. During the periods of low water in 1887 and 1888 this boat was employed in removing obstructions until the funds were exhausted, after which, in December, 1888, it was transferred for temporary use in Red River below Fulton. In February, 1891, the snag boat was sold to the work of improving Red River, Louisiana and Arkansas, for $1,500, and the proceeds of the sale were applied to removal of obstructions above Fulton, in connection with the appropriation of September 19, 1890. In January and February, 1891, the snag boats *Howell* and *Breck* were employed in going over the work, and operations of the former extended upstream to within 30 miles of the upper limit, as far as the boat was able to go on the stage of water, and a fair steamboat channel was cleared for navigation at high stages of water, practically completing the project for this improvement.

As there was no plant belonging to this work, and in order to derive the greatest benefit to navigation from the small amount appropriated by the act of July 13, 1892, it was decided to defer operations until one of the Lower Red River snag boats could be spared at a favorable stage of water, and then to push the work as rapidly as possible until the funds were exhausted. In accordance with this plan work during the fiscal year 1893 was continued, as follows:

The United States snag boat *C. W. Howell*, M. B. Lydon, master, commenced operations at Fulton January 1, and continued upstream to the mouth of Kiamichi River, reaching the latter point February 16, 1893. Owing to a high stage at Fulton and for some distance above, caused by water out of Little and Sulphur rivers, little work was done below the Texarkana and Fort Smith Railway Bridge, about 23 miles above Fulton, but above that point the river was at a favorable stage for operations and remained low during the entire period, and effective work was done. Before the Red River Raft was opened there was a high stage in the upper river for a large proportion of the year, but now the stream generally is confined within its banks and is scouring rapidly. The master of the *Howell* reported that he found great improvement in the depth of channel since the last work, in February, 1891, the stages having been near extreme low water, but the boat crossed the bars without difficulty. As it was impracticable to attempt the removal of all obstructions in the river with the small amount available, operations were confined to clearing a safe low-water channel for passage of the *Howell*, which will widen and scour. Owing to the constant scour, the majority of the obstructions encountered were removed more easily than when the last work was done, but some of the snags were imbedded to a depth of 10 to 15 feet, and their removal was difficult work. In some instances the channel cleared in 1891 was found to have changed to the other side of the river, caused by piles of drift, and in such cases the clearing was done where there was greatest probability of permanency. As there was no fuel to be purchased along this stretch of river, operations were delayed somewhat by the necessity of cutting the wood required to run the boat.

The *Howell* turned back at the mouth of Kiamichi River February 17, 1893, and arrived at Fulton the evening of February 21. As Red River above mouth of Little River had reached a low stage at that time, it was decided to take advantage of the favorable opportunity while the snag boat was available and expend the balance of the appropriation in working over the portion below the Texarkana and Fort Smith Railway Bridge, omitted the first trip, and thoroughly remove all obstructions that could be reached with the dragchain, continuing operations upstream until the funds were exhausted. Work was resumed February 22 and continued until March 11, when, on account of a rapid rise, it was suspended and the *Howell* left for the lower river. During this period operations were carried from Fulton upstream to White Oak Shoals, near the railway bridge.

The following is a summary of the work of the *Howell* during the year, viz:

| | |
|---|---|
| Snags pulled | 666 |
| Stumps pulled | 38 |
| Shore snags cut | 82 |
| Logs removed from channel | 302 |
| Side jams removed | 2 |
| Leaning trees cut | 91 |

This part of Red River has scoured and improved considerably since the work of the snag boats in 1891, and the work of the *Howell* the past season will aid in securing a better channel at all stages of water, but the amount of commerce and navigation above Fulton is as yet so limited that it is not believed that any extensive improvement is required at present, and the recommendation contained in my annual reports of 1891 and 1892 is repeated, viz:

> This part of the river is navigable for the smallest boats, and during high stages only. Lanesport, Ark., near the Indian Territory line, 74 miles above Fulton, usually is considered the upper limit of navigation, but boats make occasional trips to Kiamichi on the highest stages of river. Below the Kiamichi, Red River has no tributary of consequence except Little River, which enters the main stream 2 miles above Fulton. The oscillations are so rapid that frequently boats can run in one direction only on a single rise, and have to regulate their trips by the quantity and duration of rainfall in the upper-river country.
>
> The banks are covered with trees constantly caving or sliding into the river, and if the removal of obstructions from the channel were continued and the timber cleared from the banks to stop further accumulations, navigation would be safer and there would be less drift to contend with in the river below Fulton, but it is doubtful if the boating period would be lengthened or the upper limit extended.
>
> I recommend one of two courses in regard to this part of Red River; either that no further work be done in it until there shall be a pressing demand for a considerable improvement from Fulton upward, including Little River, both to gain a better and longer period of navigation and to help drain the adjacent lands; or else that a liberal amount, say not less than $10,000, shall be given in a single appropriation to allow the systematic clearing of the banks and removal of logs from the channelway to permit the bottom to scour. In no other way can the money be expended economically or any appreciable results obtained. The cost of organization and administration will be about the same for a small appropriation as for a large one, and the cost of getting the plant to the scene of operations and returning it to the fleet, or other work, will reach together nearly $1,000. The estimate is submitted with the idea of sending all the snag boats in Red River to work together under one management just as soon as the spring floods begin to subside, the snag boats to be employed on the wrack heaps and heavy obstructions, and the chopping parties to clear the banks, so that all loose stuff shall go out on the first and succeeding rises. This will allow about six weeks' to two months' work of the snag boats, the lightest draft boat being kept perhaps somewhat longer, and the boat with the chopping party continuing on downstream on bank work and small jams. About $1,000 should be held in reserve to send a snag boat over the whole the following season to dislodge heavy drift and pick up channel snags.

*Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $220.74 |
| Amount appropriated by act approved July 13, 1892 | 3,500.00 |
| | 3,720.74 |
| June 30, 1893, amount expended during fiscal year | 3,428.09 |
| July 1, 1893, balance unexpended | 292.65 |
| July 1, 1893, outstanding liabilities | 1.29 |
| July 1, 1893, balance available | 291.36 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895<br>Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893. | 10,000.00 |

### COMMERCIAL STATISTICS.

The river, from the mouth of Kiamichi, the upper limit of improvement, to Fulton, is paralleled by a branch of the Texas and Pacific Railroad from Texarkana to Paris, Tex., connecting at the latter place with the St. Louis and San Francisco Railroad, which crosses Red River at Arthur, Tex., above the head of navigation. The Texarkana and Fort Smith Railway crosses the river about 10 miles north of Texarkana, and the St. Louis, Iron Mountain, and Southern Railway crosses at Fulton.

No commerce or navigation of Red River above Fulton, Ark., was reported for the past fiscal year.

## V 3.

## IMPROVEMENT OF OUACHITA AND BLACK RIVERS, ARKANSAS AND LOUISIANA.

Ouachita (the Indian name for black) River has its source in Polk County, Ark., in the Ouachita Mountains, and following an irregular course flows in a general southeasterly direction through Arkansas and Louisiana until joined by Tensas and Little rivers at Trinity, La. Below this junction it is known as Black River and flows in a southerly direction, entering Red River 35 miles above its mouth. The entire length of Ouachita River is about 500 miles and that of Black River is 47 miles.

Under river and harbor act of 1870 an examination was made and a project submitted for temporary improvement from Arkadelphia, Ark., to the mouth of Ouachita by the removal of snags and dredging at the worst bars, at an estimated cost of $98,300 (Report Chief of Engineers, 1871, pp. 334–346), and the removal of obstructions was commenced in 1871. A survey of the Ouachita from Camden, Ark., to Trinity, La., was ordered by act of 1871, the report on which recommended improvement by locks and dams (Report of Chief of Engineers, 1872, pp. 367–374), and contract was let for furnishing timber for foundations of three locks. In February, 1873, the maps and notes of the survey were reviewed by a board and a resurvey was ordered by the Department, which was finished in 1874. In view of the cost of slack-water navigation as compared with the amount of commerce reported, it was considered inexpedient to go on with construction of locks and dams, and, upon the recommendation of the officer in charge, the project was abandoned and the available funds were applied to construction and operation of a snag boat and to building dikes at the shoals. The project under which work below Camden, Ark., has been carried on since 1874 contemplates the removal of snags, logs, wrecks, leaning timber, etc., and the improvement of shoal places by dams and dredging. Black River was added under the same head of appropriation with Ouachita by act of 1884. The distance from Camden, Ark., to mouth of Black River is 341 miles. No estimates of cost are given, as the nature of the work requires that it be continuous.

Since the plan of improvement by locks and dams was laid aside three examinations have been ordered with a view to reviving the subject, but all the reports agree in recommending that the project approved by the Department and adopted in 1874, and under which operations have been conducted since, should not be changed until the country is more thickly settled and an increase of trade developed to justify a large expenditure for permanent improvement.

The appropriations have been as follows:

| Date of act. | Locality. | Amount. |
|---|---|---|
| Mar. 3, 1871 | Between Arkadelphia, Ark., and Louisiana State line | $25,000 |
| Do | Between Arkansas State line and Trinity, La | 26,000 |
| June 10, 1872 | Between Arkadelphia, Ark., and Louisiana State line | 60,000 |
| Do | Between Arkansas State line and Trinity, La | 40,000 |
| Mar. 3, 1873 | do | 60,000 |
| Aug. 14, 1876 | Between Camden, Ark., and Trinity, La | 12,000 |
| June 18, 1878 | do | 10,000 |
| Mar. 3, 1879 | do | 10,000 |
| June 14, 1880 | do | 8,000 |
| Mar. 3, 1881 | do | 12,000 |
| Aug. 2, 1882 | do | 12,000 |
| July 5, 1884 | Between Camden, Ark., and mouth of Black River, Louisiana | 15,000 |
| Aug. 5, 1886 | do | 17,500 |
| Aug. 11, 1888 | do | 20,000 |
| Sept. 19, 1890 | do | 15,000 |
| July 13, 1892 | do | 40,000 |
|  | Total amount appropriated | 382,500 |

The total amount expended to June 30, 1892 (including outstanding liabilities of $13.17), was $340,463.84, of which $226,875.97 had been applied to operations under the project of 1874. The iron-hull snag boat *O. G. Wagner* was purchased for this work in 1875 and repaired with a new steel bottom in 1886. Under provision of the act of 1888 the small wooden steamer *Hooker* was purchased that year and fitted up for light snagging in Ouachita River and tributaries. From 1875 to the end of the fiscal year 1892 operations were carried on whenever funds were available for the purpose, and the work done consisted chiefly of removing wrecks, snags, logs, and tree slides from the channel and cutting leaning timber, though an increased depth was gained at some of the shoals by construction of stone and brush wing dams.

My project of July 22, 1892, for application of the appropriation of $40,000, made by river and harbor act approved July 13, 1892, contained estimates for the expenditure of the funds available as follows:

| | |
|---|---|
| For repairing snag boat *Hooker*, about | $3,500.00 |
| For surveys and levels, and plant and work at Catahoula Shoals, about | 20,000.00 |
| For general improvement, snagging operations and clearing the banks between Camden, Ark., and mouth of Black River, minor repairs and care of plant when not in use, levels and gauges, office expenses, etc., about | 13,536.16 |
| For preliminary examination and work at Camden, Ark., if found worthy of improvement after such examination, about | 5,000.00 |
| Otherwise this amount to be applied to the general improvement of the river. | |
| Total available | 42,036.16 |

The last item of this estimate was made with reference to the provision of the act stating that "not exceeding $5,000 may be used, in the discretion of the Secretary of War, at the harbor of Camden, Ark."

By Department letter of August 3, 1892, I was notified that—

> The project is approved excepting as to application of $5,000 at the harbor of Camden, Ark. The proposed examination of this locality is authorized, and after that is made a special report respecting this provision of the act should be submitted to this office for action by the Secretary of War.

An examination and survey of the Camden Reach were made by Assistant Engineer John Ewens in October, 1892, and report and a map of the locality were forwarded to the Department, through the Division Engineer, February 11, 1893, showing that the work desired at Camden is the improvement of the steamboat landing by stopping the scour from local drainage and the wash from rapid oscillations of the river, and to prevent the recurrence of either; and that the river itself does not require improvement at that point, as there is no navigation from below until boats can pass the bars between Camden and Monroe. The grading and paving of the bank at Camden would be a valuable improvement to the town, but not a proper charge against the appropriation for improving Ouachita River, unless provided for by law. For these reasons, the opinion was given that the "harbor of Camden, Ark.," was not worthy of improvement by the General Government, nor the work a public necessity. The cost of the survey and examination amounted to $151.17, and it was recommended that the remainder of the allotment of $5,000 ($4,848.83) be applied to the general improvement of the river below Camden, according to the project approved August 3, 1892. This recommendation was concurred in by the Division Engineer and the Chief of Engineers and approved by the Secretary of War February 21, 1893.

In the past year the season favorable to operations in Ouachita River and tributary streams was unusually short; the main river was at a high stage until late in August, rose again at the end of November, and remained too high to resume work with advantage to the close of the year.

Operations during the fiscal year ending June 30, 1893, were as follows:

The river having fallen to 5 feet on the gauge at Monroe, La., a chopping party was organized at that place, August 27, 1892, under Overseer F. L. Baugh, for the purpose of thoroughly removing obstructions above Monroe to the Arkansas State line, where operations were stopped by high water in December, 1891, and then to go over the work done in 1890–'91 above the State line to Camden. Work with this party was carried upstream to Extra Landing, Ark., 56 miles above Monroe, where it was suspended by high water November 4, 1892. Continued high stages prevented resuming operations after that date, and the plant used by the party was laid up at Alabama Landing.

The principal work of this party was done at the following places, viz, Hearn Mill, where several dangerous channel snags were destroyed; Pargoud Mound, cleared of trees and stumps; Harrison wood yard, cleared of shore snags and leaning trees; channel above mouth of D'Arbonne, cleared of snags; Riversticks, both sides of river cleared of leaning timber; part of wreck of steamer *H. Hanna Blanks* and sunken barge alongside removed (stage of water too high at the time to remove entire wreck with explosives); bend below Baker Landing, cleared of leaning trees; foot of Rock Row Shoals, snags removed from channel; Lonewa Landing, cutting dangerous leaning trees; clearing short point and bend at Jule Park's; clearing short point and bend 2 miles above Ouachita City; removing trees that had caved in at Mill Bayou; destroying side jam at Fish Trap Shoals; clearing Dog Island of trees and large accumulation of drift; cutting dangerous leaning trees opposite Alabama Landing; removing dangerous channel snags, clearing leaning timber and cutting shore snags at the Thirteen Points; removal of side jam in bend above Frank Pierce Creek; destroying snags on Shiloh Shoals, where river was obstructed by heavy gum and oak logs, giving only 9 inches depth of channel, the removal of which resulted in a straight channel with 22 inches depth of water; clearing Mallard points and bends of leaning timber and shore snags; clearing leaning timber at short point and bend at Julia Ann Creek; removing side jam at Moores Shoals; clearing leaning trees and shore snags along both sides of river between Moores Shoals and Line Landing; clearing point and bend above State line of leaning trees and shore snags, and removing leaning timber along both banks and numerous channel snags in the narrow stretch below Extra Landing.

The following is a summary of the work done by the chopping party, viz:

| | |
|---|---|
| Snags and logs removed from channel | 350 |
| Stumps removed from channel | 2 |
| Side jams removed | 3 |
| Shore snags removed | 2,576 |
| Leaning trees cut | 23,610 |
| Leaning trees topped | 3 |
| Trees girdled | 7,737 |
| Square yards brush and willows cut | 1,325 |

Wrecks removed, viz: Part of steamer *H. Hanna Blanks*, 353 tons, sunk above mouth of Bayou D'Arbonne December, 1889, and sunken barge alongside.

This work put the river between Monroe, La., and the Arkansas State line in fairly good condition for navigation at stages when boats can run. To extend the period of low-water navigation on this stretch, and at the request of the steamboat men, the chopping party was directed, the latter part of October, to turn back and work over it again, removing any obstructions missed on the way up, and to build brush dams to give greater depth at the sand bars, but high water prevented carrying out the plan.

In August, 1892, the United States snag boat *O. G. Wagner*, A. P. Boardman, master, was sent to this work from Shreveport, La., and, after working its way down Red River, entered the mouth of Black River September 14, and was employed in that stream and Lower Ouachita, below Monroe, La., until November 19, 1892. During this period the weather and stages of water were favorable, and effective work was done from the mouth of Black River up. November 20–December 2, 1892, the boat was employed in the river above Monroe, supplementing the work done by the chopping party, but by the time it reached Camden the river was rising rapidly, and December 3–6 the boat returned to Monroe. As the oscillations of the Ouachita are rapid, the water at times rising suddenly for a few days and subsiding as fast, the *Wagner*, with a reduced crew, remained at Monroe until December 14, waiting to see if the river would fall to a stage favorable for resuming work; but finding that high water apparently had set in for a period of long duration the boat was ordered to Alexandria to assist in the work on Red River at that place, and made the run from Monroe to Alexandria December 14–19.

The following is a summary of the work done by the snag boat *Wagner*, viz:

| | |
|---|---|
| Snags pulled | 346 |
| Stumps pulled | 57 |
| Logs removed from channel | 651 |
| Tree slides removed from channel | 2 |
| Side jams removed | 10 |
| Shore snags cut | 1,497 |
| Stumps cut, or removed with explosives | 498 |
| Leaning trees cut | 509 |
| Leaning trees topped | 18 |
| Trees girdled | 112 |

Wrecks removed, viz, steamboat wheel and shaft at Monroe, La., and a part of steamer *Edna* (time wrecked unknown), at Columbia, La.

The work of the *Wagner* improved the lower river greatly from Monroe to the mouth of Black River, but should be resumed as soon as practicable to remove obstructions brought in during the present high water. It was intended to destroy the wreck of the steamer *Idaho* (sunk 1869) at Neal's Landing, about 25 miles below Columbia, which is a serious obstruction to steamboats at low stages, but when the *Wagner* reached that place in November the stage of water was too high to do the work effectively. The master of the *Wagner* reported that the banks from Monroe to Extra Landing, the stretch worked over by the chopping party, were free of obstructions, but above the latter place further work is needed for the removal of leaning timber in imminent danger of caving into the river, no work having been done since 1891.

No work was done at Catahoula Shoals during the year, as the dredge and other plant required were in use at Alexandria, on Red River, during the short period of low water. In order to benefit navigation as much as possible with the least expenditure, and at the same time not put in any construction not adapted to a well-considered plan for permanent improvement, the approved project for work at this place contemplates blasting and dredging the rock from the point on the left bank above the shoals, where the current naturally tends to swing down downstream boats, and that a cut be made on the east side of the present channel through the shoals and the old State work, closing the lower end of the wing-dam from the right bank, and possibly easing off the point of the latter if it should be found advisable before finishing the work. Part of the material removed should be deposited in the bend above, the heavier being used to form a dike, and the remainder to be deposited along the right bank. This was the plan recommended when the report and maps of the survey of this obstruction were submitted (Report Chief of Engineers, 1891, pp. 1967-1969). As soon as there is a reasonable prospect of a continued stage of low water, it is intended to commence this work and carry it to completion as rapidly as possible.

I renew the recommendations made in my reports for 1890, 1891, and 1892 (see Report Chief of Engineers, 1891, pp. 1969-1972), for reconnaissance, with the view of repairing the levees on the river below Monroe, establishing and maintaining permanent gauges at important points at the mouths of the tributary streams, Bayous Bartholomew, Boeuf, Tensas, and Macon, and for an extensive survey of the whole river from Arkadelphia to Red River.

Accurate levels are of the first importance in determining the limits of high and low water, in connection with measurements of discharge at various stages, and for ascertaining the limits of the lands that might be subject to overflow in case the plan of obtaining uninterrupted navigation by locks and dams should be revived.

The estimate for the survey is low, considering the probable cost of a slackwater system, for which the most complete and accurate information is required.

*Detailed estimates.*

| | |
|---|---|
| For the snag-boat service | $16,000 |
| Expenses of chopping parties | 8,000 |
| Repairs and outfit | 2,000 |
| Dredging in Black River | 2,000 |
| Gauges, leveling, and reconnaissance | 5,000 |
| Assistant engineers and draftsmen | 2,000 |
| Survey of Ouachita River | 150,000 |
| Office expenses, stationery, mileage, and contingencies | 1,500 |
| Total | 186,500 |

### *Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $2,049.33 |
| Amount appropriated by act approved July 13, 1892 | 40,000.00 |
| | 42,049.33 |
| June 30, 1893, amount expended during fiscal year | 11,473.35 |
| July 1, 1893, balance unexpended | 30,575.98 |
| July 1, 1893, outstanding liabilities | 14.92 |
| July 1, 1893, balance available | 30,561.06 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895 | 186,500.00 |

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

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#### COMMERCIAL STATISTICS.

In the past fiscal year the river was reported navigable for three months to Arkadelphia, and from Camden to the mouth of Black River from November 1 to end of the year.

*List of steamboats engaged in the trade during fiscal year.*

| Names of steamboats. | Class. | Tonnage. | Length. | Breadth. | Depth. | Draft. | | | | Between— | Round trips. | Passengers. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Light. | | Loaded. | | | | |
| | | | Feet. | Feet. | Feet. | Ft. | In. | Ft. | In. | | | |
| Ouachita | Stern-wheel. | 457.45 | 189.0 | 38.0 | 6.5 | 3 | 6 | 10 | 0 | New Orleans and Monroe, La. | 26 | 1,099 |
| John Howard | ...do | 329.69 | 180.0 | 36.0 | 6.0 | 2 | 6 | 7 | 6 | New Orleans, La., and Camden, Ark. | 13 | 130 |
| City of Camden | ...do | 297.00 | 175.0 | 35.0 | 5.5 | 2 | 6 | 7 | 6 | ......do | 3 | ...... |
| Josie W | ...do | 156.40 | 140.9 | 30.4 | 4.8 | 2 | 6 | 6 | 6 | New Orleans and Monroe, La. | 18 | 216 |
| Parlor City | ...do | 136.30 | 125.0 | 26.0 | 3.7 | 2 | 6 | 6 | 0 | Monroe, La., and Bayou Bartholomew | 13 | 50 |
| | | | | | | | | | | Monroe, La., and Boeuf River. | 5 | 25 |
| | | | | | | | | | | Monroe and Alabama Landing, La. | 1 | 10 |
| | | | | | | | | | | Monroe, La., and Camden, Ark. | 1 | ...... |
| | | | | | | | | | | Monroe and New Orleans, La. (with barges). | 1 | ...... |
| Belle D'Arbonne | ...do | 74.59 | 111.0 | 22.0 | 3.7 | 2 | 0 | 4 | 0 | Monroe, La., and Camden, Ark. | 5 | 25 |
| | | | | | | | | | | Monroe, La., and Bayou D'Arbonne and Corney. | 14 | 136 |
| Addie | ...do | 12.54 | 81.0 | 18.0 | 2.0 | 0 | 11 | 2 | 6 | ....do | 32 | 147 |
| | | | | | | | | | | Monroe, La., and Camden, Ark. | 5 | 34 |
| | | | | | | | | | | Monroe and Alabama Landing, La. | 1 | ...... |
| Helen Vaughan | ...do | 89.96 | 100.5 | 25.0 | 4.2 | 1 | 0 | 3 | 6 | Monroe, La., and Bayou D'Arbonne and Corney. | 15 | 100 |
| H. W. Graves | ...do | 31.22 | 94.6 | 17.6 | 3.0 | 1 | 2 | 3 | 0 | Monroe, La., and Camden, Ark. | 6 | 20 |
| | | | | | | | | | | Monroe, La., and Saline River. | 24 | 50 |
| | | | | | | | | | | Monroe, La., and Bayou D'Arbonne and Corney. | 5 | ...... |
| Garland | ...do | 261.42 | 162.0 | 30.0 | 4.8 | 1 | 8 | 6 | 0 | Monroe, La., and Boeuf River. | 4 | 8 |
| Danube | ...do | 232.32 | 175.0 | 33.8 | 5.1 | 2 | 0 | 5 | 6 | New Orleans, La., and Tensas River, and Bayou Macon. | 11 | ...... |
| Nora | ...do | 99.53 | 120.0 | 26.0 | 4.0 | ...... | | ...... | | Wheeling, W. Va., and Bayou Bartholomew. | 2 | ...... |
| Marco | ...do | 43.90 | 104.3 | 19.0 | 2.6 | 1 | 0 | 2 | 0 | Not reported | ...... | ...... |
| Marcus Collins | ...do | 48.14 | 90.0 | 17.0 | 2.5 | 1 | 1 | 3 | 0 | ......do | ...... | ...... |

*Commercial statistics*—Continued.

| Names of steamboats. | Class. | Tonnage. | Length. | Breadth. | Depth. | Draft. Light. | Draft. Loaded. | Between— | Round trips. | Passengers. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | *Feet.* | *Feet.* | *Feet.* | *Ft. In.* | *Ft. In.* | | | |
| Laura Blanks | Stern-wheel. | 62.73 | 104.8 | 21.3 | 3.8 | 1 8 | ...... | Not reported | .... | ...... |
| Sterling White | Side-wheel. | 117.09 | 120.0 | 30.5 | 4.2 | 2 0 | 4 6 | ......do | .... | ...... |
| Albert Lea | ...do | 24.47 | 64.8 | 12.3 | 4.0 | 2 6 | 4 0 | ......do | .... | ...... |
| Arthur | Stern-wheel. | 141.72 | 76.7 | 20.0 | 3.0 | 2 0 | 3 0 | Camden and Little Bay, and Davis Landing, Ark. | 21 | ...... |
| Eva S.* | ...do | ...... | ...... | ...... | ...... | ...... | ...... | Not reported | .... | ...... |
| Gen. H. F. Devol* | ...do | 156.99 | 130.0 | 22.5 | 3.8 | ...... | ...... | New Orleans, La., and Camden, Ark. | 3 | ...... |
| Lillie† | ...do | 61.42 | 120.0 | 26.0 | 3.5 | ...... | ...... | Mouth of Red River and Jonesville, La. (towing logs). | .... | ...... |
| Ida B. Cothell† | ...do | 57.08 | 92.7 | 22.1 | 3.7 | ...... | ...... | New Orleans, La., and Little River. | 1 | ...... |
| Grover K.* | Tug | 4.00 | ...... | ...... | ...... | 2 4 | ...... | Knight Landing, La., and Bayou Lewis. | 40 | 80 |
| Julia* | ...do | 4.88 | ...... | ...... | ...... | 3 0 | ...... | Jonesville, La., and Little River, Bayou Castor, and Bayou Dugdemona. | 6 | 30 |
| Irwin* | ...do | 3.00 | ...... | ...... | ...... | 2 2 | 2 4 | Stafford Point, La., and Boeuf River and tributaries. | 100 | 225 |

* Tow one or more barges. † Tow-boats.

*Summary of commerce reported.*

| Articles. | 1892-'93. | 1891-'92. | 1890-'91. | 1889-'90. | 1888-'89. |
|---|---|---|---|---|---|
| | *Tons.* | *Tons.* | *Tons.* | *Tons.* | *Tons.* |
| Cotton | 11,383 | 21,890 | 21,433 | 16,652 | 17,788 |
| Cotton seed | 4,423 | 5,577 | 6,593 | 5,058 | 2,660 |
| Hides and skins | 4 | 7 | 25 | 36 | 23 |
| Live stock | 845 | 89 | 172 | 62 | 213 |
| Lumber | 18,000 | 461 | 16,388 | 7,951 | 5,963 |
| Saw logs | 28,000 | 26,880 | 120,000 | 50,000 | ............ |
| Staves | 9,878 | 23,402 | 17,888 | 21,150 | 8,500 |
| Rock | ............ | ............ | 18,000 | ............ | ............ |
| Miscellaneous | 5,251 | 5,197 | 10,856 | 783 | 1,096 |
| Total down freight | 77,284 | 83,503 | 211,355 | 101,701 | 36,342 |
| Return freight | 11,157 | 18,317 | 27,842 | 40,766 | 24,228 |
| Total | 88,441 | 101,820 | 239,197 | 142,467 | 60,570 |
| Estimated value | $4,466,000 | $6,680,600 | $9,130,000 | $10,234,250 | $8,798,000 |

NOTE.—The fluctuations in tonnage and value of commerce are due to the uncertainty of the logging business, which requires high water and other abnormal conditions for success. Flood water from the Mississippi, through crevasses in Arkansas and Louisiana, prevented any crop in 1892 on a large part of Lower Ouachita Valley.

The competing routes of transportation are as follows:

Ouachita River is crossed by the St. Louis, Iron Mountain and Southern Railway at Arkadelphia, Ark., by the St. Louis Southwestern Railway (Cotton Belt Route), at Camden, Ark., and by the Vicksburg, Shreveport and Pacific Railroad at Monroe, La. The St. Louis and Iron Mountain Railway has a branch line parallel to the river from Camden to Gurdon, Ark., and thence by the main line to Arkadelphia. A projected extension of this branch will give direct communication with the Mississippi River at Arkansas City, the part to be built being from Camden to Warren, Ark., a distance of about 50 miles. The Houston, Central Arkansas and Northern Railroad (another branch of the Missouri Pacific system), connects with Arkansas City at McGehee, 12 miles west, and thence runs in a southwesterly direction about midway between Bayou Bartholomew and Boeuf River, touches Ouachita River and crosses the Vicksburg, Shreveport and Pacific Railroad at Monroe, La., and continues down parallel to the main river to Columbia, La., crossing at Riverton, 4 miles above Columbia, and runs thence to Alexandria, La. The Natchez, Red River and Texas Railroad (narrow gauge) runs from Black River Station, opposite Trinity, to Vidalia, La., on the Mississippi opposite Natchez. This road has a small triweekly packet running in Black River. The New Orleans and Northwestern Railway, completed from Natchez, Miss., to Rayville, La., crosses Tensas River near its mouth; and the projected extension of this road will cross Boeuf River a short distance north of Rayville, and Bartholomew near Bastrop, La.

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## V 4.

### IMPROVEMENT OF BAYOUS D'ARBONNE AND CORNEY, LOUISIANA.

Bayou D'Arbonne is formed by the junction of the south, middle, and north, or Corney branches, near Farmerville, Union Parish, northern Louisiana; flows in a southeasterly direction, and enters Ouachita River 6 miles above Monroe, La. The course of the bayou is very tortuous, through an alluvial bottom, varying in width from 1 mile at the head of navigation to 5 or 6 miles at its mouth, which is overflowed during high water to a depth of from 5 to 15 feet. In its windings the stream touches the hills at several places, which serve as shipping points for the country back of them.

An examination and a survey, directed by river and harbor act of 1882, were made in 1883, and the project for improvement was based upon the latter. The bayou is navigable only at high stages, and it was believed that by the removal of snags, logs, wrecks, and leaning timber from Stein Bluff on the Corney Branch to the mouth of the bayou, 42½ miles, the boating season would be lengthened two months and navigation made less hazardous at all times. The estimated cost of such improvement was $15,000 if spent in two consecutive seasons. (Report Chief of Engineers, 1884, pp. 1372–1381.)

The following appropriations have been made:

| By act of— | |
|---|---|
| July 5, 1884 | $5,000 |
| August 5, 1886 | 2,000 |
| August 11, 1888 | 2,000 |
| September 19, 1890 | 2,000 |
| July 13, 1892 | 4,000 |
| Total | 15,000 |

The improvement was begun in the autumn of 1884; the first work (let by contract at a cost of $197.50 per mile), commenced at the mouth, was carried upstream about 23 miles, and suspended December 11, 1884. This work having shown that the contract method was not well adapted to the class of work required, and not the most economical means of carrying out the project, subsequent operations were conducted by hired labor. The appropriation of 1886 was expended that fall and the following summer in going over the lower 23 miles of the bayou and continuing the work upstream about 6 miles. In the summer of 1889 operations were resumed and carried up to Stein Bluff. In December, 1890, a chopping party was sent to go over the work, navigation having been reported much obstructed by fallen timber. Work commenced at Stein Bluff January 7, 1891, and was carried downstream about 9 miles, when rainy weather set in and operations had to be suspended on account of high water, and were not resumed to the end of that fiscal year. In August and September, 1891, the entire stretch from

Stein Bluff to the mouth was worked over thoroughly at a low stage of water.

Considerable work had been done by steamboat men in the way of clearing leaning timber and removing the worst snags before the improvement was undertaken by the United States, and in 1883 the bayou was reported navigable from six to seven months of the year. The work done by the United States extended the period of navigation fully one month, enabled boats of double the capacity of those formerly used to run in the stream to advantage and with less risk, shortened the time of trips, and reduced freight rates one-half.

No work was done during the fiscal year ending June 30, 1893, on account of the limited period of low water. The approved project provided for carrying on work in Bayou D'Arbonne and other tributaries to Ouachita River (Bartholomew, Boeuf, Tensas, and Maçon), with the same party and outfit for all, transferring from one stream to another according to stages of water, or as the funds ran out. This party was employed during the short low-water season in Bayou Maçon, Louisiana. It is intended to resume the work as soon as the water reaches a low stage, with a party large enough to complete operations before the next high-water season.

The work is not permanent, as new obstructions are added from time to time; but although the original project contemplated completing operations from Stein Bluff to the mouth in two consecutive seasons, at a cost of $15,000, and although the aggregate of the appropriations for that stretch in a period of nine years is $1,000 less than the original estimate, it is believed that with the funds now available the work can be completed so thoroughly as not to require further attention for several years.

Within the last few years navigation of the Corney Branch has extended upstream to Cobb Landing, about 4 miles above Harris Bluff and 16½ miles above Stein Bluff, for the benefit of a growing community, embracing the towns of Shiloh on one side of the bayou and Spearsville on the other, and the act of 1892 provided that $1,000 of the amount appropriated for "completing improvement" of Bayou D'Arbonne "shall be expended in improvement of the Corney from Steins Bluff to the head of navigation on said stream." This portion of the stream was not included in the original project, and there has been no work in it except that done recently by the steamboats aided by the shipping interest, who now ask that the project be amended for the purpose of extending operations up to Cobb Landing, the present head of navigation. The stream between Stein Bluff and Harris Bluff was included in the survey of 1884, and it was reported that it would require an entire season's operations to remove the obstructions, at a cost of $7,000, but the officer in charge considered that it would be of doubtful utility at that time. (Report Chief of Engineers, 1884, pp. 1376–1381.)

At the urgent request of the owner of the steamboat running in Bayou Corney above Stein Bluff, an effort was made last fall to apply the allotment for that stretch to the removal of obstructions, as far as practicable with the limited amount; but before the party could be organized and arrangements made for delivering the necessary outfit of tools and explosives the water rose and remained too high for advantageous work to the close of the fiscal year.

In view of the modification of the project by river and harbor act of July 13, 1892, extending the improvement above Stein Bluff to head of navigation at Cobb Landing, it is estimated that it will require $6,000 to complete the work.

*Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $125.06 |
| Amount appropriated by act approved July 13, 1892 | 4,000.00 |
| | 4,125.06 |
| July 1, 1893, balance unexpended | 4,125.06 |
| Amount (estimated) required for completion of existing project | 6,000.00 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895. | 6,000.00 |
| Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893. | |

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COMMERCIAL STATISTICS.

In the past fiscal year the bayou was navigable for ten months. August and September are the months of low water.

*List of stern-wheel steamboats that navigated Bayou D'Arbonne in fiscal year 1893.*

| Name. | Tonnage. | Length. | Breadth. | Depth. | Draft. | | Between— | Round trips. | Passengers. |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Light. | Loaded. | | | |
| | | *Feet.* | *Feet.* | *Feet.* | *Ft. in.* | *Ft. in.* | | | |
| Addie | 21.66 | 84.1 | 18.0 | 2.0 | 0 10 | 2 6 | Monroe and Lawrence Ferry. | 3 | 147 |
| | | | | | | | Monroe and Cobb Landing. | 4 | |
| | | | | | | | Monroe and Shiloh | 2 | |
| | | | | | | | Monroe and Beech Bluff | 2 | |
| | | | | | | | Monroe and Colvin | 1 | |
| | | | | | | | Monroe and Farmersville. | 21 | |
| | | | | | | | Monroe and Stein Bluff | 1 | |
| Helen Vaughan | 85.95 | 100.5 | 25.0 | 4.2 | 1 0 | 3 6 | Monroe and Cobb Landing. | 15 | 100 |
| H. W. Graves | 31.22 | 94.6 | 17.6 | 3.0 | 1 2 | 3 0 | do | 5 | ..... |
| Belle of D'Arbonne | 74.50 | 111.0 | 22.0 | 3.7 | 1 0 | 2 6 | Monroe and Farmerville | 14 | 136 |

The freights reported were as follows:

| Articles. | 1892-'93. | 1891-'92. | 1890-'91. | 1889-'90. | 1888-'89. |
|---|---|---|---|---|---|
| | *Tons.* | *Tons.* | *Tons.* | *Tons.* | *Tons.* |
| Cotton | 1,839 | 2,610 | 2,738 | 1,500 | 2,500 |
| Cotton seed | 180 | ......... | 500 | 1,000 | ......... |
| Hides | ......... | ......... | 4 | ......... | 5 |
| Lumber (principally logs) | 16 | 1,123 | 9,000 | 10,250 | ......... |
| Cotton-seed meal | 250 | 150 | ......... | ......... | ......... |
| Staves | ......... | 10 | ......... | ......... | ......... |
| Miscellaneous | 1,893 | 668 | 543 | ......... | ......... |
| Total down freights | 4,178 | 4,561 | 12,785 | 12,750 | 2,505 |
| Return freights | 1,324 | 1,697 | 1,187 | 1,666 | 1,670 |
| Total freights | 5,502 | 6,258 | 13,972 | 14,416 | 4,175 |
| Estimated value | $440,000 | $617,240 | $683,500 | $646,000 | $500,000 |

The bayou is the only available means for transporting crops and supplies, except by hauling long distances in wagons to the Vicksburg, Shreveport and Pacific Railroad on the south, to the branch railroad at Eldorado, Ark., or to the Ouachita River.

## V 5.

## IMPROVEMENT OF BAYOU BARTHOLOMEW, LOUISIANA AND ARKANSAS.

Bayou Bartholomew has its source in Jefferson County, southeastern Arkansas, within a few miles of Pine Bluff, and following a tortuous course, flows at first nearly parallel to Arkansas River at a distance varying from 15 to 30 miles, then parallel to the Mississippi, at about the same average distance, but after entering Louisiana turns to the southwest and finally enters Ouachita River in Morehouse Parish, opposite Ouachita City. The total drainage area of the bayou and tributaries is about 1,800 square miles. The States of Louisiana and Arkansas made expenditures at various times for its improvement, navigation of the stream having been carried on to considerable extent as early as 1843.

Examinations of the bayou were made in accordance with requirements of river and harbor acts as follows: From its mouth to the Arkansas State line, act of March 3, 1871; from Baxter, Ark., to its mouth, acts of June 18, 1878, and June 14, 1880; and above Baxter to the Lincoln County line, Arkansas, act of July 5, 1884. Reports upon these examinations are contained in reports of the Chief of Engineers, viz: 1872, pages 383–386; 1879, pages 997–1003; 1881, pages 1453–1457; and 1885, pages 1548–1552.

The project for the improvement adopted in 1881 contemplated the removal of snags, logs, wrecks, leaning timber, etc., to give safe navigation from Baxter, Ark., to the mouth, a distance estimated to be about 150 miles. The original estimate of cost for two consecutive seasons' work was $26,862, but as new obstructions are added every year no estimate for permanent improvement has been made.

The following appropriations have been made:

| By act of— | |
|---|---|
| March 3, 1881 | $8,000 |
| August 2, 1882 | 5,000 |
| July 5, 1884 | 5,000 |
| August 5, 1886 | 5,000 |
| August 11, 1888 | 5,000 |
| September 19, 1890 | 5,000 |
| July 13, 1892 | 5,000 |
| Total | 38,000 |

The work was commenced by hired labor July 20, 1881, at Baxter, Ark., and was carried downstream to Bartholomew, Ark., where operations were suspended December 25, 1881, by high water. Operations were resumed August 29, 1882, at the latter place, and were continued downstream to Lind Grove, La., and discontinued December 1, 1882, by high water. Owing to lack of funds nothing further was done until the appropriation of 1884 was made, when it was decided to give the contract system a trial upon this and other tributaries of Ouachita River. Contract was let for the removal of obstructions at $75 per mile, and work commenced at the mouth November 10, 1884, extended upstream 66⅝ miles, and was suspended December 7, 1884. Nothing was done the following year, as no appropriation was made, and operations were not resumed until November 20, 1886. The contract method having failed to prove satisfactory or economical to the United States, a chopping party commenced work at the mouth on the latter date and continued upstream until stopped by high water, January 20, 1887, at Point Pleasant, La. Operations were resumed July 25, 1887, at Poplar Bluff, Ark., and continued downstream to Point Pleasant, and suspended September 10, 1887, the funds being exhausted. Nothing further was done until August 6, 1889, when a chopping party commenced work at the mouth, continued upstream about 90 miles to Oak Landing, and there suspended operations November 21, 1889. In February, 1890, the United States snag boat *Hooker* made a patrol as high as Ohio Landing, Ark., about 118 miles above the mouth, removing jams of drift, etc. Operations were resumed by a chopping party May 11, 1891, at Portland, Ark., about 35 miles below Baxter, and carried downstream to the mouth, and suspended August 14, 1891.

It will be seen from the foregoing that operations have extended over the entire portion of the bayou included in the project, and that the worst stretches have been worked over two and three times, but not thoroughly, and in two consecutive seasons, as was contemplated. However, the intermittent work during the period of eleven years benefited navigation to a great extent. Before the improvement commenced, the average duration of the navigable season was three months; now there is better navigation for about six months, and boats of double the capacity make trips with greater safety in half the time; and the rates of freight are reported to have been reduced 50 per cent.

No work was done during the fiscal year ending June 30, 1893, on account of the limited period of low water. The approved project provided for carrying on work in Bayou Bartholomew and other tributaries to Ouachita River (D'Arbonne, Bœuf, Tensas, and Macon), with the same party and outfit for all, transferring operations from one stream to another, according to the stages of water, or as the funds ran out. This party was employed during the low-water season in Bayou Macon, La. As soon as practicable after the season of low water sets in, it is intended to resume the work with a party large enough to apply the amount available before the next high-water season. The bayou between the mouth and Portland, Ark., will be worked over first, to remove obstructions added since operations were suspended in 1891, after which the removal of obstructions will be continued upstream to Baxter, if possible with the funds available.

It would be of great advantage to the shipping interest to have gauges at convenient points, as at Baxter or Portland, Ark., on the Missouri Pacific system, to inform steamboat men when they could enter the stream and the depths they could carry on the shoals. These stations are but 14 and 28 miles from the Coast Survey precise bench at McGehee, Ark., and would require only 31 miles of leveling to connect them with the Cairo datum.

With a gauge at the mouth of Ouachita River, the approximate limits of high and low water could be determined in one season and the probable depths at low water taken from soundings while removing obstructions. The cost of this work is insignificant compared with the information and benefits that would result. Other points might be reached by a line of levels down the Houston, Central Arkansas and Northern Railroad to Monroe, La., but the line would not be essential except for a survey of the bayou in connection with the improvement of Ouachita River. The cost of establishing two gauges, leveling, and wages for observers would fall within $500. No separate estimate is made for this work, as it properly would be chargeable to the improvement of the stream.

### *Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $348.10 |
| Amount appropriated by act approved July 13, 1892 | 5,000.00 |
| July 1, 1893, balance unexpended | 5,348.10 |
| July 1, 1893, outstanding liabilities | .92 |
| July 1, 1893, balance available | 5,347.18 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895 | 10,000.00 |

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

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### COMMERCIAL STATISTICS.

In the past fiscal year the bayou was reported navigable from December 1 to June 30.

*List of steamboats engaged in navigating Bayou Bartholomew during fiscal year 1893.*

| Name. | Class. | Tonnage. | Length. | Breadth. | Depth. | Draft. | | Between— | Round trips. | Passengers. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Light. | Loaded. | | | |
| | | | *Feet.* | *Feet.* | *Feet.* | *Ft. in.* | *Ft. in.* | | | |
| Sterling White | Side-wheel | 117.09 | 120.0 | 30.5 | 4.2 | 2 0 | 4 6 | No report | .... | .... |
| Parlor City | Stern-wheel | 136.30 | 125.0 | 26.0 | 3.7 | 2 0 | 6 0 | Monroe and Lloyd. | 13 | 50 |
| Nora | ....do | 99.53 | 120.0 | 26.0 | 4.0 | ...... | ...... | Monroe and Point Pleasant. | 1 | .... |

The commerce reported was as follows:

| Articles. | 1892-'93. | 1891-'92. | 1890-'91. | 1889-'90. |
|---|---|---|---|---|
| | *Tons.* | *Tons.* | *Tons.* | *Tons.* |
| Cotton | 1,000 | 2,372 | 3,971 | 2,000 |
| Cotton seed | 1,300 | 3,326 | 2,467 | 4,000 |
| Cotton-seed meal | ........ | 1,425 | 516 | ........ |
| Saw logs | 2,000 | 4,450 | 20,080 | 11,839 |
| Staves | 2,375 | 1,648 | 17,822 | ........ |
| Miscellaneous | 175 | 410 | 1,340 | ........ |
| Total down freights | 6,850 | 13,631 | 46,196 | 17,839 |
| Return freights | 825 | 1,534 | 3,103 | 4,000 |
| Total freights | 7,675 | 15,165 | 49,299 | 21,839 |
| Estimated value | $136,000 | $515,000 | $826,000 | $492,709 |

This stream is crossed at Baxter, Ark., the upper limit of improvement, by a branch of the St. Louis, Iron Mountain and Southern Railroad, which connects with the Mississippi River at Arkansas City, Ark., runs west 56 miles to Warren, Ark., and probably will be extended to Camden, on the Ouachita, which is connected with the main line by a branch to Gurdon, Ark. The Houston, Central Arkansas and Northern Railroad (another branch of the Missouri Pacific system) runs parallel to Bartholomew from McGehee, Ark., to Monroe, La. The projected extension of the New Orleans and Northwestern Railway, north of Rayville, La., will cross Bayou Bartholomew on a line from Bastrop, La., to Hamburg, Ark.

## V 6.

## IMPROVEMENT OF BŒUF RIVER, LOUISIANA.

Bayou Bœuf, usually called Bœuf River, has its source in Chicot County, southeastern Arkansas, flows in a general southwesterly direction, and enters Ouachita River at Stafford Point, 8 miles above Harrisonburg, Catahoula Parish, La. The improvement of this stream was undertaken by the State of Louisiana more than half a century ago, the report of the board of public works of 1840 stating that it had been opened to Point Jefferson.

An examination was made in 1880, in accordance with requirements of river and harbor act of June 14, 1880 (Report Chief of Engineers, 1881, pp. 1424–1428), and the project based thereon contemplated removing snags, logs, leaning timber, etc., obstructing navigation at high stages from Wallace Landing to the mouth, a distance estimated to be about 152 miles. The cost of removing the obstructions in two consecutive seasons was estimated at $20,000, but as new obstructions are added every year and require removal from time to time, no estimate for permanent improvement has been made.

River and harbor act of July 5, 1884, directed an examination of three outlets near Point Jefferson, Louisiana, with a view to closing them. The report thereon recommended the closure of the outlets as necessary to preserve navigation in the stream (Report Chief of Engineers, 1885, pp. 1545–1548), and this addition to the project was approved by act of 1886, which provided for "continuing improvement, and for closing Outlet Number One."

The following appropriations have been made:

| | |
|---|---|
| By act of— | |
| March 3, 1881 | $5,000 |
| August 2, 1882 | 5,000 |
| July 5, 1884 | 5,000 |
| August 5, 1886 | 5,000 |
| August 11, 1888 | 6,000 |
| September 19, 1890 | 5,000 |
| July 13, 1892 | 10,000 |
| Total | 41,000 |

The improvement was commenced, by hired labor, at Point Jefferson in August, 1881, and work of a chopping party was carried downstream about 100 miles, and suspended at the close of November, 1881, when the available funds were exhausted. Operations were resumed September 9, 1882, and between that date and December 20, 1882, the portion of the river above the railroad crossing near Girard, La., to Point Jefferson was worked over by a chopping party. Nothing further was done until appropriation was made by act of 1884, when it was decided to give the contract method a trial upon the tributaries to Ouachita River. On Bœuf River the work was let at $75 per mile; operations commenced November 15, 1884, at the mouth, extended up stream 60 miles, and were suspended December 11, 1884. The next appropriation provided for continuing the improvement and closing Outlet Number One, but after a reëxamination it was found essential that all three outlets be closed, and, by uniting with the planters whose lands would be protected, this was done in 1887 and 1888, the proportion of cost borne by the United States having been $5,441.78. Outlet No. 1 was closed substantially, the second outlet was closed by a heavy dam, and the third by a low dam, which was all the work that could be done with the insufficient appropriation and the assistance rendered by the planters. The removal of obstructions, by hired labor, was resumed November 8, 1888, and between that date and May 22, 1889, operations were carried from Point Jefferson to the mouth, but work was suspended from January 1 to April 25, 1889, by high water. The small balance available was expended in December, 1889, for operations of the snag boat *Hooker* in working over the 60 miles above the mouth. September 28 to December 12, 1891, a chopping party worked from the mouth up to a point 9½ miles above the Vicksburg, Shreveport and Pacific Railroad Bridge. The water was at a low stage during the entire period, and thorough and effective work was done.

The removal of obstructions from 1881 to the close of the calendar year 1891 enabled steamboats to run to Point Jefferson with greater safety. Below the railroad bridge, on the portion worked over in 1891, boats can navigate at any stage high enough to enable them to cross the bars, without danger of knocking down chimneys, damaging upper works, or losing freight in leaning timber, at a saving of at least 36 hours time on the round trip.

The closure of the three outlets near Point Jefferson in 1887–'88 gave immediate benefit to navigation by confining the flow to its natural direction, and by scouring the bars below, but during the overflow from the Mississippi River, caused by breaks in the levees in the spring of 1890, all the dams were destroyed. As soon as the appropriation of 1890 became available an examination was made to determine the extent of the damage, and with a view to repairing the dams, if practicable, before high water set in. Owing to the isolated situation and the greater difficulty of obtaining earth than when the first closure was made, it was estimated that $12,000 would be required to close the three outlets and connect them with the parish levees. It being essential that all the outlets should be closed substantially and at the same time, to prevent backwater attacking the dams from the rear, the amount available having been much too small for the purpose, and inquiry having shown that no aid could be expected from local levee boards or owners of land adjacent to the outlets, it was decided to apply the available funds to the removal of obstructions, and defer rebuilding the dams until an appropriation was made for the purpose.

But on April 17, 1893, the river being about half stage at and above the railroad crossing at Girard, La., and with favorable conditions in sight, I sent Assistant Eastwood to reëxamine the outlets and the old connecting levees between them, intending to advertise the work with the hope of receiving a low bid, levee work on Mississippi and Red rivers being nearly finished for the year. The unfortunate crevasses in the Arkansas levees occurring shortly afterwards, have made it impossible to do any work of the kind till late in the season, when prices again will be high, and this furnishes another argument in favor of putting it off until a special appropriation shall be made, or else giving it over altogether. The results of the examination, briefly, are as follows: The dam at Outlet No. 1 is entirely washed away to about the height of ordinary low water, with the exception of the south wing. The dam at No. 2 is standing, but the old levee and bank on the west side show a deep wash below low water. The dam at No. 3, built by a planter to back water up Bayou Bonne Ideé to get a steamboat in for cotton, was not expected to withstand high water; but if appropriation had been made according to the original estimate for closing all three outlets at the same time, it would have been raised above high water and done much to insure the safety of the system.

All of these outlets should be closed and connected by a line of levee at least 3 feet above highest water mark, extending above No. 3 to the nearest high ground and below No. 1 far enough to prevent back wash on the dam. To close No. 1 alone, as first provided, is not only to waste money but to invite disaster.

The estimates for the work are as follows:

| | |
|---|---|
| Dam at No, 1, 21,000 cubic yards; dam at No. 2, 15,000 cubic yards; dam at No. 3, 24,000 cubic yards; total, 60,000 cubic yards, at 25 cents | $15,000 |
| Connecting levees, 50,000 cubic yards, at 15 cents | 7,500 |
| Pile wing dams to deflect the current at each outlet below 4-foot stage, 1,500 linear feet, at $4 | 6,000 |
| Office charges, inspection, and contingencies | 1,500 |
| Total for three outlets | 30,000 |
| Continuing improvement of the river, labor, plant, and supplies | 10,000 |
| | 40,000 |

The estimates are much greater than those submitted by me heretofore, because it is almost certain that no help will or can be given by the parish police jury or by the people who would be protected from overflow by the proposed improvement, and in fact it should be unreasonable to expect any help from a people who have been almost ruined by the criminal neglect of another State to do its part toward restraining the floods of Arkansas and Mississippi rivers within their own borders.

The proposed wing dams are single rows of piles driven close together and well into the bottom, with their tops about 4 feet above ordinary low water, the object being to increase the depth at and below the outlets and protect the foot of the dams from drift on rising water.

A large appropriation for continuing the removal of snags, clearing the banks, etc., can be used to greater advantage and with far greater economy than a small one, the cost of organization and administration being almost as much for an appropriation of $5,000 as for twice that sum, while the amount of work should be more than doubled.

No work was done during the fiscal year ending June 30, 1893, on account of the limited low-water season. As a measure of economy, the approved project provided for carrying on work in the tributaries to Ouachita River with the same party and outfit for all, transferring operations from one stream to another according to stages of water, or as the funds ran out. The party was employed during the short period of low water in Bayou Maçon, Louisiana.

*Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $304.93 |
| Amount appropriated by act approved July 13, 1892 | 10,000.00 |
| | 10,304.93 |
| June 30, 1893, amounted expended during fiscal year | 144.90 |
| July 1, 1893, balance unexpended | 10,160.03 |
| July 1, 1893, outstanding liabilities | 22.54 |
| July 1, 1893, balance available | 10,137.49 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895<br>Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893. | 40,000.00 |

### COMMERCIAL STATISTICS.

This river was reported navigable to Point Jefferson from December 1, 1892, to June 30, 1893.

*List of steamboats engaged in navigation during the year.*

| Name. | Class. | Tonnage. | Length. | Breadth. | Depth. | Draft. Light. | Draft. Loaded. | Between— | Round trips. | Passengers. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | *Feet.* | *Feet.* | *Feet.* | *Ft. in.* | *Ft. in.* | | | |
| Garland | Stern-wheel. | 261.42 | 162.0 | 30.0 | 4.8 | 2 0 | 5 6 | New Orleans and Eason Ferry.<br>New Orleans and R. R. bridge. | 2<br>2 | 8 |
| Marcus Collins | ...do... | 48.14 | 90.0 | 17.0 | 2.5 | 1 1 | 3 0 | No report | | |
| Parlor City | ...do... | 136.30 | 125.0 | 26.0 | 3.7 | 2 0 | 6 0 | Monroe and Jordan | 5 | 25 |
| Joe, with barges | Tug... | 18.07 | 44.5 | 10.0 | 4.0 | 3 6 | 5 9 | New Orleans and Bœuf River. | 1 | .... |
| Irwin | ...do... | 6.72 | 47.0 | 12.2 | 5.0 | 2 2 | 2 2 | Stafford Point and Prairie Landing.<br>Stafford Point and Deer Creek.<br>Stafford Point and Turkey Creek. | 50<br>25<br>25 | ....<br>....<br>.... |

*Summary of commerce reported.*

| Articles. | 1892-'93. | 1891-'92. | 1890-'91. | 1889-'90. | 1888-'89. |
|---|---|---|---|---|---|
| | *Tons.* | *Tons.* | *Tons.* | *Tons.* | *Tons.* |
| Cotton | 626 | 1,583 | 1,760 | 1,397 | 1,084 |
| Cotton seed | 1,878 | 1,178 | 716 | 731 | 834 |
| Hides and skins | ........ | 50 | ........ | ........ | ........ |
| Live stock | ........ | 19 | ........ | ........ | ........ |
| Lumber | 250 | 1,352 | ........ | ........ | ........ |
| Saw logs | ........ | 1,223 | ........ | ........ | ........ |
| Staves | 923 | 3,138 | 1,777 | 268 | 54 |
| Miscellaneous | 300 | 72 | 179 | ........ | 91 |
| Total down freights | 3,977 | 8,615 | 4,482 | 2,391 | 2,063 |
| Return freights | 335 | 1,370 | 3,458 | 1,594 | 1,[illegible]76 |
| Total freights | 4,312 | 9,985 | 7,890 | 3,985 | 3,439 |
| Estimated value | $200,000 | $501,000 | $636,500 | $580,850 | $457,100 |

The Vicksburg, Shreveport and Pacific Railroad crosses Bœuf River near Girard, La., and the projected line of the New Orleans and Northwestern Railway will cross about 1¼ miles north of Rayville, La. The Houston, Central Arkansas and Northern Railroad runs parallel to the river on the west, and a new line is projected (Louisiana, Arkansas and Missouri Railroad) which will touch the river at several points on the east.

## V 7.

## IMPROVEMENT OF TENSAS RIVER AND BAYOU MAÇON, LOUISIANA.

Tensas River has its source in Lake Providence, in northeastern Louisiana, within 2 miles of the Mississippi River, flows in a general southerly direction, gradually diverging from the Mississippi, and joins Ouachita and Little rivers at Trinity, La., in forming Black River. Bayou Maçon was united under the same head of appropriation with Tensas River by the act of 1884. This stream rises in Desha County, southeastern Arkansas, near the source of Bœuf River and a few miles west of the Mississippi, flows in a general southerly direction west of and nearly parallel to the Tensas, and enters the latter about 40 miles above its mouth.

In accordance with river and harbor act of June 14, 1880, examinations of both streams were made in 1880, upon which the plan for their improvement is based. The project contemplated removing snags, logs, and leaning timber obstructing navigation; in Tensas River, from Dallas, La., to its mouth, about 134 miles, at an estimated cost of $23,000; and in Bayou Maçon, from Floyd, La., to its mouth, about 98 miles, at an estimated cost of $17,000. (Report Chief of Engineers, 1881, pp. 1457–1467.) The estimates were based upon calculations for continuous work in one low-water season, and, in view of the appropriations made, are without value, as new obstructions are added every year and require removal in the interest of safe navigation from time to time.

The following appropriations have been made:

| By act of— | |
|---|---|
| March 3, 1881 | $3,000 |
| July 5, 1884 | 4,000 |
| August 5, 1886 | 4,000 |
| August 11, 1888 | 5,000 |
| September 19, 1890 | 5,000 |
| July 13, 1892 | 5,000 |
| Total | 26,000 |

The improvement of Tensas River was commenced by hired labor in September, 1881, at Dallas, La., where the Vicksburg, Shreveport and Pacific Railroad crosses the river; work was carried downstream to near Buckner Place and suspended the latter part of December, 1881. The next work was let by contract, at the rate of $125 per mile; operations commenced at the mouth October 29, 1884, were carried upstream about 29 miles, and suspended November 28, 1884. The contract method failed to prove satisfactory or economical for the class of work required in these streams, and subsequent operations were conducted by hired labor. As no work had been done in Bayou Maçon, the appropriation of 1886 was applied to that stream. Operations commenced November 14, 1886, and were suspended the latter part of January, 1887, work during this period having extended from Floyd to the mouth of the bayou. In October, 1887, this work was gone over from Floyd down to Oakley, about 22 miles above the mouth, operations consisting chiefly of the destruction of accumulations of drift, most of which was burned. Work was resumed February 1, 1889, and continued until April 22, 1889, extending over the entire portion of Bayou Maçon included in the project and about 25 miles of Tensas River between Mound Bayou and Tensas Bluff. The wreck of the steamboat *H. J. Dickey* was removed from Bayou Maçon, near Delhi, La., December 17, 1891, and from December 29, 1891, until January 12, 1892, a chopping party was employed in removing obstructions, chiefly in the channel, from the lower 40 miles of Bayou Maçon, work having been stopped the latter date by high water.

The total amount expended to June 30, 1892, was $17,980.64, of which $7,529.25 were applied to improving Tensas River and $10,451.39 to Bayou Maçon. The obstructions were removed as far as practicable with these amounts, and in Bayou Maçon, the principal commercial branch, improved navigation so as to shorten the time of trips about twelve hours.

During the fiscal year ending June 30, 1893, operations were continued as follows:

The gauge at the railway bridge near Delhi, La., where the plant used upon this work had been laid up since operations suspended in

January, 1892, showed a fall from 29½ feet July 1 to 3 feet August 21, 1892. The boats having been repaired in advance, a chopping party was organized at that place, August 22, under Overseer Watkins Decker, and proceeded up stream to Floyd, La., reaching that place August 24. Active operations commenced at Floyd Landing the following day and were continued down Bayou Maçon until December 22, 1892, when work was suspended by high water at Oak Bluff Bayou, about 16 miles above the mouth. The quarter boat and barge were dropped drown stream to the New Orleans and Northwestern Railway Bridge across Tensas River and laid up, and the party was disbanded. Continued high stages to the end of the fiscal year prevented resuming work.

From Floyd down to Poverty Point the bayou was very narrow, and considerable clearing was done to give an increased width of about 20 feet at the narrowest places. All dangerous channel snags, stumps, and shore snags were removed on the way. From Epps down to Herald Place little work was required, as the bayou throughout that stretch ranged from 125 to 250 feet in width and from 12 to 25 feet in depth at the low stage of water, but all dangerous channel snags, shore snags, stumps, and logs that were visible were removed, and also one tree slide near Oak Landing. Below the Herald Place to mouth of Joe's Bayou the stream is narrow and crooked and, as a general thing, shallow, with an occasional deep pool, and ranges from 35 to 80 feet wide at a low stage. This stretch was obstructed badly by overhanging timber and brush, which was cut or girdled; six tree slides were removed, and all dangerous channel snags, shore snags, and stumps were cut or destroyed. Seventy-five snags and logs were removed under and around the Vicksburg, Shreveport and Pacific Railroad Bridge, and also a part of the wreck of the steamboat *H. J. Dickey*, which had floated down to that place and sunk. Thirty-seven stumps in the channel in front of Travis Place were destroyed. From Joe's Bayou down to Campbell Place the bayou is wide and deep, and little work was needed. Between Nugia Scott's Landing and Alf Scott's Landing the bayou is narrow, and was obstructed by leaning timber on the banks and numerous stumps in the channel. The timber was cut or girdled, and twenty-two stumps were destroyed between the landings. From Jackson Place down to Richland Place progress was slow, as the channel was badly obstructed by snags, stumps, logs, and overhanging timber, the tops of the trees at places almost meeting across the bayou. These obstructions were removed, the most notable improvement having been gained at Floyds Place, where the channel was obstructed by logs and stumps and leaning timber on both banks; Collins Place, where the stream was narrow and obstructed by leaning timber and snags; at the Moore Place, where a large oak tree had slid into the bayou, almost blocking the channel; at Andrews Place the channel was badly obstructed by large caved-in trees; and just above Warsaw Landing a large number of snags, stumps, and trees were removed from the channel. Below Warsaw to Crockett Point the Bayou was wide and in fairly good condition, and little work was needed. At Crockett Point it narrows, and for a distance of a mile below was full of snags, which were removed and the timber cleared from the banks. From Richland Place to Killion Gin, a stretch known as "the Wilderness" because no plantations border it, the bayou was much obstructed by snags, logs, stumps, and trees which had blown into the stream, all of which were removed. At the request of steamboat men, the mouth of the small bayou above Killion Gin was cleared of trees and brush, to give a place for boats to turn around, as steamboats frequently run to that point and have been compelled to back out to Tensas River, on account of the narrow channel. Along the front of Hall Place numerous stumps and shore snags were removed. Below that point to Wards the stream was in fair navigable condition, but from Wards to the Avenue it is narrow, and heavy work was required. From the Avenue down to Oak Bluff Bayou the stream was obstructed by snags, logs, and stumps, which were cut or destroyed, notable work having been done between Eureka Landing and Higginbottoms and from Brawhaws to Kimbles.

The following is a summary of the work reported, viz:

| | |
|---|---|
| Snags removed from channel | 7,837 |
| Stumps removed from channel and banks | 11,597 |
| Shore snags removed | 13,028 |
| Logs removed from channel and banks | 15,288 |
| Leaning trees cut | 58,336 |
| Trees girdled | 53,338 |
| Square yards of brush and willows cut | 50,035 |

This work was done thoroughly and at a low stage of water, when the majority of the obstructions in the channel were visible; it has reduced the dangers of navigation in Bayou Maçon to Floyd to a minimum, and should enable boats to make the trip in 6 to 8 hours less time. As soon as the water is low enough to work to advantage, operations will be resumed in the lower part of Bayou Maçon. Lower Tensas River, from the mouth up to the junction with the Maçon, is comparatively free of obstructions and needs no work at present, and if there is a balance available after completing operations in Bayou Maçon it will be applied to the removal of obstructions in upper Tensas River.

Although new obstructions are added from time to time, it is believed that with the balance of the original estimate ($14,000) in a single appropriation both streams may be cleared of obstructions so thoroughly as not to need further attention for years.

Gauges should be established on both of these streams on the line of the Vicksburg, Shreveport and Pacific Railroad, both to ascertain their rise and fall and to give information to steamboat men. The cost of the service should not exceed $200 a year for each gauge. A gauge at the bridge of the New Orleans and Northwestern Railway across Tensas River at Daniels Ferry would be useful, and could be established and set to Cairo datum at a cost of about $20.

*Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $3,019.36 |
| Amount appropriated by act approved July 13, 1892 | 5,000.00 |
| | 8,019.36 |
| June 30, 1893, amount expended during fiscal year | 6,444.00 |
| July 1, 1893, balance unexpended | 1,575.36 |
| July 1, 1893, outstanding liabilities | 38 |
| July 1, 1893, balance available | 1,574.98 |
| Amount (estimated) required for completion of existing project | 14,000.00 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895 | 14,000.00 |
| Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893. | |

### COMMERCIAL STATISTICS.

The river and bayou were reported navigable from November 15, 1892, to June 30, 1893.

*List of steamboats engaged in navigation of Tensas River and Bayou Maçon during the fiscal year 1893.*

| Name. | Class. | Tonnage. | Length. | Breadth. | Depth. | Draft. | | Between. | Round trips. |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Light. | Loaded. | | |
| | | | *Feet.* | *Feet.* | *Feet.* | *Ft. In.* | *Ft. In.* | | |
| Danube | Stern-wheel. | 232.32 | 175.0 | 33.8 | 5.1 | 2 0 | 5 6 | New Orleans and Warsaw | 8 |
| | | | | | | | | New Orleans and Como Landing. | 1 |
| | | | | | | | | New Orleans and Joes Bayou. | 1 |
| | | | | | | | | New Orleans and Upper Tensas. | 1 |
| Marco | ...do | 43.90 | 104.3 | 19.0 | 2.6 | 1 0 | 2 | Not reported | .... |
| Marcus Collins | ...do | 48.14 | 90.0 | 17.0 | 2.5 | 1 1 | 3 0 | ......do | .... |
| Laura Blanks | ...do | 62.73 | 104.8 | 21.3 | 3.8 | ...... | ...... | ......do | .... |
| Eva S. | ...do | 50.00 | ...... | ...... | ...... | 0 11 | 2 6 | ......do | .... |
| Albert Lea | Side-wheel. | 24.47 | 64.8 | 12.3 | 4.0 | 2 6 | 4 0 | ......do | .... |

*Summary of commerce reported.*

| Articles. | 1892-'93. | 1891-'92. | 1890-'91. | 1889-'90. | 1888-'89. |
|---|---|---|---|---|---|
| | *Tons.* | *Tons.* | *Tons.* | *Tons.* | *Tons.* |
| Cotton | 498 | 3,762 | 2,760 | 1,527 | 2,750 |
| Cotton seed | 1,457 | 4,876 | 4,850 | 2,920 | 4,000 |
| Hides and skins | 3 | .......... | 10 | 2 | 5 |
| Live stock | 3 | 10 | 6 | .......... | 225 |
| Staves | 26 | 71 | 1,032 | 3,325 | 3,500 |
| Lumber | .......... | 440 | .......... | .......... | .......... |
| Miscellaneous | .......... | 1,942 | 378 | 56 | 1,823 |
| Total down freight | 1,987 | 11,101 | 9,036 | 7,824 | 12,303 |
| Return freight | 662 | 5,886 | 6,000 | 5,216 | 8,202 |
| Total | 2,649 | 16,987 | 15,036 | 13,040 | 20,505 |
| Estimated value | $122,500 | $990,000 | $999,500 | $742,390 | $1,194,100 |

The Vicksburg, Shreveport and Pacific Railroad crosses Bayou Maçon near Delhi, La., and the Tensas River at Dallas, La. The New Orleans and Northwestern Railroad crosses Tensas River near Daniels Ferry, Concordia Parish, La.

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## V 8.

## IMPROVEMENT OF BIG BLACK RIVER, MISSISSIPPI.

Big Black River has its source in Webster County, Miss., flows in a general southwesterly direction, and enters Mississippi River at Grand Gulf, 37 miles below Vicksburg, having a length estimated to be about 400 miles.

Under river and harbor act of March 3, 1881, an examination of this stream was made, and the project submitted for its improvement contemplated two seasons' work in clearing a channel suitable for navigation at high stages of water by the removal of snags, logs, leaning timber, etc., from Cox Ferry to the mouth, about 130 miles, at an estimated cost of $32,000.

The following appropriations have been made:

| By act of— | |
|---|---|
| July 5, 1884 | $5,000 |
| August 5, 1886 | 5,000 |
| July 13, 1892 | 5,000 |
| Total | 15,000 |

The first appropriation was expended in 1884–'85, when a chopping party removed the principal obstructions for a distance of about 75 miles above the mouth.

The act of 1886 required that no part of the appropriation should be used until the State of Mississippi caused the bridges below the Vicksburg and Meridian Railroad to be so constructed as not to obstruct navigation. The bridges referred to were a county bridge at Baldwin Ferry, about 70 miles above the mouth; a county bridge at Ivanhoe Ferry, about 50 miles above the mouth; and the Louisville, New Orleans and Texas Railway Bridge, about 15 miles above the mouth. The fixed railway bridge was changed to a swing bridge in 1889, in accordance with an act of the State legislature, and the Ivanhoe Bridge was replaced by a ferry in 1887.

The river and harbor act of 1890 removed the restriction contained in the act of 1886 and authorized the expenditure of the appropriation. The project was modified to include only that part of the river below the Baldwin Ferry Bridge, and in 1891 a snag boat and chopping party were employed on that stretch; the principal work done was between Baldwin and Ivanhoe ferries, a distance of about 20 miles.

No work was done during the fiscal year 1892, no funds being available, and operations have not been resumed under the act of July 13, 1892, for the reason that the season of low water was short and more important works of the district required attention first.

The fixed wooden bridge at Baldwin Ferry was replaced during the year with a permanent iron swing bridge, plans of which were approved by the Secretary of War April 28, 1892.

In view of the small amount of commerce in this stream, the fact that there is no probability of an increased business for years to come, and the cost of maintaining unobstructed navigation by the removal of snags and drift and leaning timber added every year, it is not believed that any further amount can be expended profitably in continuing the work, and for this reason no estimate is submitted.

## *Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $248.77 |
| Amount appropriated by act approved July 13, 1892 | 5,000.00 |
| | 5,248.77 |
| June 30, 1893, amount expended during fiscal year | 162.84 |
| July 1, 1893, balance unexpended | 5,085.93 |
| July 1, 1893, outstanding liabilities | .96 |
| July 1, 1893, balance available | 5,084.97 |

### COMMERCIAL STATISTICS.

This stream was reported navigable from the latter part of December, 1892, to end of the fiscal year. The head of navigation is the Alabama and Vicksburg Railway bridge, 13 miles east of Vicksburg.

*List of stern-wheel steamboats engaged in navigating Big Black River during fiscal year 1893.*

| Names. | Tonnage. | Length. | Breadth. | Depth. | Draft. |  | Between— | Round trips. |
|---|---|---|---|---|---|---|---|---|
|  |  |  |  |  | Light. | Loaded. |  |  |
|  |  | *Feet.* | *Feet.* | *Feet.* | *Ft. In.* | *Ft. In.* |  |  |
| Vesper | 73.64 | 110.5 | 20.8 | 4.0 | ........ | ........ | Vicksburg and Baldwin Ferry. | 1 |
| L. H. Sargent | 85.46 | 116.2 | 22.4 | 4.3 | 1 10 | 3 0 | Vicksburg and Reagan Island. | 1 |
| Dyersburg | 73.08 | 93.0 | 18.4 | 3.0 | 1 6 | 3 0 | Vicksburg and Mackey Ferry. | 1 |
| Joe (tug) | 18.07 | 44.5 | 10.0 | 4.0 | 5 6 | 5 9 | Vicksburg and Cox Ferry.<br>Vicksburg and Cowan Place. | 1<br>1 |

*Summary of commerce reported.*

| Articles. | 1892–'93. | 1891–'92. | 1890–'91. |
|---|---|---|---|
|  | *Tons.* | *Tons.* | *Tons.* |
| Cotton | ........ | ........ | 13 |
| Cotton seed | 125 | ........ | 12 |
| Lumber | 30 | ........ | 2 |
| Staves | 2,238 | 1,499 | 471 |
| Provisions | 60 | ........ | 22 |
| Grain | ........ | ........ | 10 |
| Saw logs | 3,000 | 14,250 | 9,449 |
| Total freights | 5,453 | 15,749 | 9,978 |
| Estimated value | $22,900 | $55,550 | $72,000 |

The Alabama and Vicksburg Railway crosses Big Black on a fixed bridge, 13 miles east of Vicksburg and the Yazoo and Mississippi Valley Railroad crosses on a swing bridge, about 15 miles above the mouth.

## V 9.

## IMPROVEMENT OF YAZOO RIVER, MISSISSIPPI.

Yazoo River, about 173 miles long, is formed by the junction of Tallahatchee and Yallabusha rivers in Leflore County, Miss., flows in a general southerly and then southwesterly direction, and enters Mississippi River 5 miles above Vicksburg.

An examination, with a view to the removal of wrecks of gunboats, steamers, and other obstructions placed in this river during the war, was ordered by the river and harbor act of June 10, 1872, and was reported upon the following year. (Report Chief of Engineers, 1873, pp. 483, 484.) A further examination was made in 1874, and estimates were submitted for thoroughly clearing the river of obstructions, within a period of four years, at a cost of $120,000; a small annual appropriation to be made thereafter for maintenance of improvement. (Reports Chief of Engineers, 1874, Part 1, pp. 364–367, and 1875, Part 1, p. 522.) In view of the appropriations made, this plan could not be carried out, and in 1875 the present project was adopted, which contemplates the removal of wrecks, snags, logs, and leaning timber obstructing navigation the entire length of the river, as far as practicable with the funds provided. New obstructions, caused by floods, sliding and caving banks, etc., are added from time to time, and the work should be gone over every year in the interest of safe navigation.

The following appropriations have been made:

| By act of— | |
|---|---|
| March 3, 1873 | $40,000 |
| March 3, 1875 | 12,000 |
| August 14, 1876 | 15,000 |
| June 18, 1878 | 25,000 |
| March 3, 1879 | 15,000 |
| June 14, 1880 | 12,000 |
| March 3, 1881 | 6,000 |
| August 2, 1882 | 8,000 |
| July 5, 1884 | $10,000 |
| August 5, 1886 | 15,000 |
| August 11, 1888 | 32,000 |
| September 19, 1890 | 25,000 |
| July 13, 1892 | 20,000 |
| Total | 235,000 |

The first appropriation was applied in 1873–'74 to the removal of the wrecks of nine vessels, sunk during the war, viz: The *Arcadia*, *R. J. Lackland*, *Golden Age*, *Glyde*, *Petrel*, *Ivy*, *Van Dorn*, *Polk*, and *Idaho*. After newspaper advertisement of fifty days only two proposals were received, and the contract was let to the lowest bidder for the aggregate sum of $35,450. Experience gained by this work showed that the improvement could be continued much more economically by the means of a snag boat operated with hired labor, and in 1875 and 1877 the United States snag boat *O. G. Wagner* was employed in removing wrecks and other obstructions. In 1879 the snag boat *John R. Meigs* was built, and the principal work since has been done with that boat. The benefits to navigation resulting from the work are marked; the large number of wrecks that obstructed the river and limited the period of navigation, many of which were sunk to prevent passage during the war, had been removed so as to present little or no obstructions, and the removal of snags, logs, leaning timber, etc., was carried on whenever funds were available for the purpose, giving steamboat navigation from head to mouth at all stages the year round. The total amount expended to June 30, 1892, was $211,926.76 (including $7.33 outstanding liabilities on that date), part of which had been applied to constructing the snag boat *Meigs* in 1879, the purchase of a pumping dredge boat under act of 1888, and to the survey of the mouth and lower river in 1890.

During the fiscal year ending June 30, 1893, operations were continued as follows:

In July and the early part of August the stages of water were too high for work. August 22, 1892, the United States snag boat *Meigs*, P. R. Starr, master, left Vicksburg and entered Yazoo River, and between that date and September 4 worked to the head of the river removing heavy tree slides and other obstructions encountered. During the remainder of the month of September the boat was employed in Tallahatchee River, but returned to the Yazoo October 1 and worked slowly downstream, as the water was at a very low stage. At McCormacks Bar the channel was found to be difficult for the passage of steamboats and a wing dam 150 feet long was built of hard timber and brush, which caused the channel to scour, giving an immediate depth of 4 feet; and subsequently the masters and pilots reported that the dam improved navigation greatly. On the way down heavy work was done at the following points and bends, viz: Roebuck Lake, Oakwood, Alligator Bayou, head of Honey Island between the two canals, Shipps, and above and below Eagle Lake Landing. After reaching Belzona the boat worked back over the stretch between that place and Eagle Bend, and then ran down to Yazoo City to work from that place to foot of Honey Island, as it is operated with greatest advantage while working upstream. In addition to the usual work of taking snags, stumps, and trees from the channel, a great many dangerous stumps and shore snags were removed, and all sliding timber in bends or on points was cleared and the stumps cut even with the ground. In the "Ox Bows," or short bends above mouth of Tchula Lake to Silver City, all old stumps and trees, shore snags, and wreck heaps were removed. After the stretch between Yazoo City and the foot of Honey Island had been worked over thoroughly, the *Meigs* moved down to the mouth of Big Sunflower River to work through "the Narrows," a stretch only 3 miles in length, but as indicated by the name, the channel is contracted, and was much obstructed by stumps, shore snags, and tree slides extending 15 to 20 feet into the river, which were removed. The steamboat *John F. Allen*, a vessel of 134 tons, 130 feet long, 24 feet beam, and 4.2 feet deep, built in 1884, and belonging to the Yazoo and Tallahatchie Transportation Company, of Vicksburg, struck an obstruction at Liverpool Landing, November 9, and sank. A large tree slide at that place caused the wrecks of two steamers, sunk in 1863, to rise in sight for the first time since the war of the rebellion. They were not obstructions to navigation until after the slide took place. The steamer *Allen* laid across the wrecks, and at the request of the owners the snag boat *Meigs* was authorized to aid the commercial boats in attempting to raise it, upon written release from all liability for damages. Three attempts were made, at different times, in which the *Meigs* assisted by pumping and by putting chains under the boat, but all were unsuccessful, and November 29 the *Meigs* came to Vicksburg to make necessary repairs of capstan machinery, boiler, and wheel. The repairs were completed December 8, and between that date and December 24 the *Meigs* was employed below Yazoo City. Operations were suspended the latter date, as the river had reached a stage too high to continue with advantage. The snag boat remained at Vicksburg until January 24, undergoing necessary repairs of machinery, pumps, breeching, and stumps of chimneys, iron bulkhead at stern, wheel, etc. January 24, the repairs were completed and the boat was ready to leave for Big Sunflower River, but at the solicitation of the superintendent of the Yazoo and Tallahatchie Transportation Company, was sent to remove a coal barge reported as obstructing navigation at Random Shot, in the narrow stream on the river side of Honey Island. The barge was found partly sunk, and was moved January 27 to a place out of reach of passing boats. During February, March, and April the *Meigs* was employed in Big Sunflower and Tallahatchie rivers, and since then the stages of water have been too high for work.

The following is a summary of the work done in Yazoo River by the snag boat *Meigs* during the year:

| | |
|---|---|
| Snags pulled | 533 |
| Stumps pulled | 363 |
| Logs removed from channel | 70 |
| Shore snags cut | 1,479 |
| Stumps cut or removed with explosives | 1,319 |
| Leaning trees cut | 9,815 |
| Leaning trees topped | 59 |
| Trees girdled | 2,076 |
| Square yards brush and willows cut | 920 |
| Linear feet brush wing dam built at McCormacks Bar | 150 |

Wrecks removed, viz.: Hog chains and braces, chimney stumps, part of roof, and main staircase steamer *Katie Robbins* (sunk 1889 near Sunflower Cut-off), coal barge at Random Shot, also caisson of old bridge pier at Yazoo City.

This work put Yazoo River in good navigable condition, but as snags and tree slides are brought into the stream at each flood the work will have to be continued for many years.

During a severe wind storm March 3, 1893, the pumping dredge boat belonging to this work and laid up in Lake Centennial at Vicksburg, was wrecked; the boat capsized from the force of the wind, and the hull broke in two and sank. After the return of the snag boat *Meigs* to Vicksburg the latter part of March, the boat was raised and moved to bank, and the greater portion of the machinery recovered. There is a balance available of $2,317.99 from the allotment by act of 1888 for constructing this boat, which probably will suffice to rebuild the hull. The rest of the plant is in good working condition, but it is probable that new boilers will be required on the *Meigs* before long, or at least that very general repairs will be necessary. The tubes have leaked more or less, and have been expanded and fitted with ferules, and 18 new tubes have been put in, and an iron deck has been ordered for the space under the boilers. As the boat carries a large crew when at work, every precaution should be taken to insure against fire and explosions.

Work in Yazoo and tributary streams could be carried on more economically if they were grouped together as a system and appropriations made under one head, with allotments for each stream. The plant could then be bought from the general appropriation and its use charged pro rata without being a heavy burden upon any one stream. A modern dredge, preferably self propelling, would be of great use in parts of Yazoo, Tchula Lake, and Big Sunflower, but the largest appropriation of late years for any one of the streams mentioned would not be sufficient for the purpose. So also with regard to pile-drivers, quarter boats, or small hand-snagging outfits, the idea being to have a district plant to be used on any of the streams of the system when needed. The estimates are made with this view, the work required not being of a kind that can be done advantageously or satisfactorily by contract. A great deal of work remains to be done in clearing the banks of leaning timber to prevent tree slides and snags, and to make the passage of the sharp bends safer, and this can be done most economically by shore parties housed and subsisted on quarter boats, leaving the heavy work to be done at the proper or convenient time by the snag boats. There are also many places where the channel is injured by dispersion, and where chutes should be closed or wingdams built. As Yazoo and tributaries are not subject to heavy drift, work of the kind need not be expensive, and probably sheet piling would answer very well.

### DETAILED ESTIMATES.

| | | |
|---|---|---|
| *General service plant.* | | |
| Dredge | $30,000 | |
| Pile-driver | 4,000 | |
| Quarter-boats | 2,500 | |
| Skiffs, tools, rigging, etc | 3,500 | |
| | | $40,000 |
| *Service of plant.* | | |
| Expenses of snag boats | 24,000 | |
| Expenses of dredges | 9,000 | |
| Expenses of shore parties | 7,000 | |
| | | 40,000 |
| *Care of plant.* | | |
| New boilers | 4,000 | |
| Hull repairs | 3,000 | |
| General and extraordinary repairs | 1,500 | |
| Fleet, wages, supplies, etc | 1,500 | |
| | | 10,000 |
| *Surveys.* | | |
| Local surveys, gauges, discharge measurements, etc | 6,000 | 6,000 |
| *Administration.* | | |
| Office expenses, rent, supplies, etc | 1,500 | |
| Assistant engineers, draftsmen, transportation, and incidentals | 2,500 | |
| | | 4,000 |
| Total | | 100,000 |

### *Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $3,080.57 |
| Amount appropriated by act approved July 13, 1892 | 20,000.00 |
| | 23,080.57 |
| June 30, 1893, amount expended during fiscal year | 11,639.15 |
| July 1, 1893, balance unexpended | 11,441.42 |
| July 1, 1893, outstanding liabilities | 19.82 |
| July 1, 1893, balance available | 11,421.60 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895<br>Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893. | 100,000.00 |

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### COMMERCIAL STATISTICS.

During July and August, 1892, navigation from Vicksburg was suspended on account of the bar at the mouth. With the mouth open, the river is navigable its entire length the year round.

*List of steamboats that navigated Yazoo River in fiscal year 1893.*

| Name. | Class. | Tonnage. | Length. | Breadth. | Depth. | Draft. | | | | Between— | Round trips. | Passengers. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Light. | | Loaded. | | | | |
| | | | Feet. | Feet. | Feet. | Ft. | in. | Ft. | in. | | | |
| Birdie Bailey | Stern-wheel. | 109.74 | 111.0 | 22.0 | 3.5 | 1 | 10 | 4 | 0 | Yazoo City and Belzona. | 96 | 2,100 |
| Blanks Cornwell | ..do | 232.40 | 140.0 | 29.0 | 4.6 | 2 | 2½ | 5 | 2 | Vicksburg and Greenwood. | 44 | 602 |
| John F. Allen | ..do | 133.90 | 130.2 | 24.0 | 4.2 | 1 | 8 | 4 | 0 | Vicksburg and Yazoo City. | 24 | 201 |
| Addie E. Faison | ..do | 241.50 | 135.0 | 30.6 | 4.9 | 2 | 2 | 5 | 0 | Vicksburg and Greenwood. | 16 | 110 |
| | | | | | | | | | | Yazoo City and Belzona. | 30 | 1,100 |
| Ike Bonham | ..do | 78.52 | 93.4 | 18.0 | 3.6 | 1 | 8 | 3 | 6 | Greedwood and Sheppardtown. | 12 | 51 |
| Hibernia | ..do | 157.06 | 135.0 | 25.0 | 4.0 | 2 | 6 | 5 | 0 | Vicksburg and Greenwood. | 2 | 1 |
| Des Arc | ..do | 40.88 | 95.0 | 18.0 | 3.0 | 1 | 4 | 3 | 0 | Yazoo City and Belzona. | 12 | 165 |
| Ferd R.* | ..do | 30 | ...... | ...... | ...... | 1 | 0 | 3 | 0 | Yazoo City and Campbellsville. | 2 | ...... |
| | | | | | | | | | | Yazoo City and Wolf Lake. | 15 | ...... |
| | | | | | | | | | | Yazoo City, Tallahatchee, and Coldwater Rivers. | 10 | ...... |
| Joe Seay† | Tug | 27.74 | 75.0 | 16.0 | 6.0 | 7 | 0 | 8 | 0 | Vicksburg and mouth Sunflower. | 1 | ...... |
| | | | | | | | | | | Vicksburg and mouth Steeles Bayou. | 15 | ...... |
| John M. Abbott | Stern-wheel. | 97.78 | 92.0 | 20.0 | 3.6 | ...... | | ...... | | Not reported | ...... | ...... |
| Lancaster† | ..do | 156.09 | 135.6 | 23.5 | 3.8 | 1 | 10 | 3 | 6 | Vicksburg and mouth Sunflower River. | 1 | ...... |
| H. M. Townsend† | ..do | 87.70 | 116.7 | 18.0 | 3.1 | ...... | | ...... | | New Orleans and Coldwater River. | 2 | ...... |
| Huston Combs, No. 2.† | ..do | 95.96 | 98.0 | 22.0 | 3.4 | 3 | 0 | 4 | 0 | New Orleans and Coldwater River. | 2 | ...... |
| | | | | | | | | | | Vicksburg and Coldwater River. | 4 | ...... |
| Joe† | Tug | 18.07 | 44.5 | 10.0 | 4.0 | 5 | 6 | 5 | 9 | Vicksburg and Wasp Lake. | 2 | ...... |
| J. B. O'Brien† | ..do | 44.49 | 70.8 | 15.2 | 7.0 | 7 | 10 | 9 | 0 | Natchez and Yazoo River. | 1 | ...... |

* Tow boats.

† With barges.

*Summary of commerce reported.*

| Articles. | 1892-'93. | 1891-'92. | 1890-'91. |
|---|---|---|---|
| | *Tons.* | *Tons.* | *Tons.* |
| Cotton | 11, 094 | 15, 653 | 13, 750 |
| Cotton seed | 12, 795 | 16, 570 | 12, 500 |
| Hides and skins | 26 | 19 | 10 |
| Live stock | 79 | 124 | 60 |
| Lumber | 3, 122 | 3, 318 | 3, 600 |
| Staves | 12, 488 | 6, 804 | 1, 350 |
| Provisions | 8, 547 | 10, 502 | 9, 020 |
| Grain | 6, 107 | 12, 531 | 11, 080 |
| Saw logs | 11, 800 | 15, 000 | 2, 140 |
| Miscellaneous | 8, 507 | 12, 624 | 10, 540 |
| Total freights for Yazoo proper | 74, 565 | 93, 205 | 64, 050 |
| Total freights from tributaries | 124, 887 | 116, 021 | 97, 588 |
| Total freights, Yazoo and tributaries | 199, 452 | 209, 226 | 161, 638 |
| Estimated value | $4, 329, 000 | $7, 351, 500 | $6, 315, 275 |

The Georgia Pacific division of the Richmond and Danville Railroad crosses Yazoo River at Fort Loring, 5 miles below Greenwood, and the Yazoo and Mississippi Valley Railroad crosses about 15 miles above the mouth. The latter has a branch from Clarksdale to Minter City, on the Tallahatchee, which will be extended down the stream to Greenwood. The Yazoo branch of the Illinois Central Railroad from Parsons, on the Yallabusha, to Jackson, Miss., runs parallel to the river, touching at Greenwood, Sidon, Tchula, and Yazoo City, and has a tap line from Tchula to the main line at Durant.

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## V 10.

## IMPROVEMENT OF MOUTH OF YAZOO RIVER, MISSISSIPPI.

The shifting bar at the mouth of Yazoo River is the most serious obstruction to commerce, and boats that could navigate the principal streams of the Yazoo Valley system (about 800 miles) without hindrance are prevented at low stages from entering or leaving without lightering, and frequently navigation across the bar is closed altogether.

The river and harbor act of 1890 directed that a survey be made from the Louisville, New Orleans and Texas Railway (now Yazoo and Mississippi Valley Railroad) Bridge to the mouth, to determine in what manner the mouth could be improved to permit free passage of vessels at all seasons of the year, and to include an investigation of the feasibility and advantage of making a new outlet for the river, by way of Chickasaw Bayou or otherwise, with an estimate of cost.

The report and maps of this survey were submitted February 4, 1892, and the report was reprinted in Report of Chief of Engineers, 1892, pages 1627-1642. The improvement proposed contemplates the formation of a new outlet from the former mouth of the Yazoo on Old River, through the deep water in Old River, across the lowlands between Long and Barnett lakes to Lake Centennial, around the head of De Soto Island, along the front of Vicksburg, and entering Mississippi River on the channel side at Kleinston. The cost of the work required was estimated at $1,500,000.

The river and harbor act of July 13, 1892, provided an appropriation of $75,000 for commencing the improvement in accordance with the foregoing project, to include borings and gaugings and obtaining the right of way, and appears to have been based upon the first item of my estimates, page 1630, report of 1892, viz: "Cost of right of way, 500 acres, more or less, clearing, grubbing, etc., $75,000."

The report of Assistant Engineer Marshall shows the progress made during the year on the survey and locations of trial and final lines for the canal. All of the field work has been plotted and the maps will be finished at an early day. The precise levels have been completed and the notes are now being checked in the office, and most of the discharge observations have been worked up. The precise levels will be of no little value to the tributary streams as well as to Yazoo River, the line serving as a base from which to run side lines from gauges to determine their rise and fall and slopes. For example, the line from Greenville, on Mississippi, to Greenwood, on Yazoo, crossed Sunflower at Baird, about 80 miles above its junction with Yazoo at L'Argent. Gauges having been established at both places, the actual differences of elevation of the water surfaces were as given in the following table, the references being in meters above Cairo datum:

| | 1893. | | | | | | |
|---|---|---|---|---|---|---|---|
| | Apr. 19. | May 23. | May 27. | May 28. | May 31. | June 3. | June 9. |
| Baird | 36.40 | 35.55 | 35.27 | 35.44 | 35.42 | 35.67 | 36.76 |
| L'Argent | 30.83 | 35.37 | 35.22 | 35.17 | 35.08 | 34.98 | 34.82 |
| Fall in 80 miles | 5.57 | 0.18 | 0.07 | 0.27 | 0.34 | 0.69 | 1.94 |
| Or in feet | 18.27 | 0.60 | 0.22 | 0.87 | 1.12 | 2.27 | 6.37 |

It will be noticed that the oscillation at Baird was small, while the water at the mouth rose considerably, and therefore the differences divided by the distance would not give the slope, but they show that without flood from Mississippi River Sunflower may become almost deadwater if not actually a reservoir for Yazoo at certain stages, or for backwater from Mississippi if the streams of the Yazoo system do not pass ordinary high water when the great river is in flood. Pilots have stated that frequently there was a strong current down Yazoo into Sunflower, and it is said that once a raft having got loose in Yazoo was found after much search about 5 miles up Sunflower. Gauges having been established at Greenwood, Satartia, the Yazoo and Mississippi Valley Railroad Bridge, and at the mouth, and read with those at Yazoo City and Kleinston, show that the high-water limit of Yazoo River, as plotted on the hydrograph of 1891, was about 3 meters (10 feet, more or less) above the high-water line of this year at all stations above the influence of backwater, the high water at Yazoo City being actually 11 feet below the high-water mark of 1882, when the levees were down, although the height at Kleinston was very near the same, being only 1 decimeter less (about four-tenths foot) this season. The discharge observations taken at L'Argent June 3, 1893, show an apparent loss in the mouth of Sunflower River, which is undoubtedly due to the fact that the current was too sluggish to be recorded by the meter. The high-water fall from Yazoo City to Kleinston this year was only 1.43 meters, and a comparison of the discharge measurements shows that unless there should be considerable breaks in the levee system the dimensions of the proposed canal should be ample.

The prolonged high water in Mississippi River this season has prevented making borings, and it is not probable that they can be commenced before September. However, it is not believed that so many will be required as first supposed, or indeed, that any serious errors would be made if it should be found impracticable to make them at all.

A few trial holes may be bored to determine the presence of rock or hard material, but it is almost certain that no drift will be found. The statement in my report of 1892, that the branches near Vicksburg called Old River and Wrong End of Old River were formerly a bend of Mississippi River, has been confirmed by the maps of Lieutenant Ross's reconnaissance of 1765, Land Grant map of 1774, and Collot's map of 1796, for copies of which I am indebted to the researches of Captain Palfrey, Corps of Engineers. These maps show the bend with Yazoo entering at the turn as described in the journal of the officer on the expedition of 1739. (Report Chief of Engineers, 1892, page 1637.) The cut-off must have occurred between 1797 and 1808, according to sailing directions published in the latter year, leaving Yazoo to find its way by either branch until the lower filled up, after which it pursued a lengthening channel as the bar advanced, its scouring power diminishing with every flood of the Mississippi, until now boats drawing 30 inches can not enter at a stage of 8 feet on the Kleinston gauge. Under such conditions it was evident that no permanent improvement could be made at the present mouth, even with unlimited funds, and therefore the plan of diverting the Yazoo, though costly, was submitted, and if this work shall not be authorized it will be best to leave things as they are, with a passable entrance for small boats for portions of each year, and probable suspensions for two or three months under certain conditions of relative stages in Yazoo and Mississippi Rivers.

The benefits of the proposed work will consist in giving a navigable outlet to the streams of the Yazoo system at all stages by turning the river past Vicksburg to enter Mississippi in deep water at the bend at Kleinston, while restoring Vicksburg's river front; reducing the backwater limit of Mississippi, and at the same time relieving the pressure on Delta Point by contributing the discharge some 4 miles further downstream, and finally in furnishing occasion for extending the line of levee protection of Yazoo Front. Steps have already been taken to organize a new levee district to fit in between the State district, which ends about 20 miles above Vicksburg, and that under the officer in charge of the fourth district of Mississippi River, with the view of coöperating with the United States and State engineers in completing the line of defense, and maps are now being made from those of the Mississippi River Commission, to be supplemented by local surveys.

With Yazoo Front permanently closed by substantial levees, the improvement of the streams forming the Yazoo system should be less expensive and more stable, since they should have only their own drainage to carry instead of being swollen by destructive additions from Mississippi River, and even if breaks should occur in the main line it is not believed that the disturbance would be either general or serious in any of them.

As the high-water line falls the banks will become more stable and caving and slides diminished, navigation made safer and more certain, and the development of the valley hastened.

In diverting the Yazoo difficulties will be encountered, some of which may not have been foreseen; the banks may not stand at so steep a slope as expected, and sudden rises may cause larger fills than anticipated before the cut is finished, but the ground has been gone over very carefully, and liberal provisions made for delays, cost of material, and rise in wages, so that it is believed that the final estimates, though $300,000 less than submitted in the first report, will cover all contingencies. The only elements of uncertainty are the relative scour and fill after the work is finished until the new river shall have established its regimen. The river in front of Vicksburg having been the Mississippi before the cut-off of 1876, and very deep, has filled with mud, and this, of course, will scour; but it may be necessary to narrow the bend called Wrong End of Old River, and to reduce the area of section in Lake Centennial to prevent dispersion. Much of the latter will be accomplished by depositing the material from the cut, and in fact perhaps all of it may be done in that way, the only doubt being lest too much be done. With regard to the dams across the present channel of Yazoo River and at West Pass, it may be that the former still will be required, though for a different reason than first given, namely, to keep the Mississippi out. Since the present mouth of Yazoo is filled with sand by Mississippi River in flood it should fill more rapidly if Yazoo is diverted, and should not scour at all, but continue to fill until above ordinary high water, just as happens at other places on Mississippi River where the bars grow out and up. The dam at West Pass may not be needed, or the filling may be done by dredging at much less cost than estimated for mattresses and piling; and, finally, it may be found unnecessary to revet the canal. The time required for the work can not be forcast, because the date of possible appropriation can not be assumed, the time for constructing the plant only approximated, and the stage of Mississippi River when the plant shall be ready is not to be predicted. The amount of levee work on the left bank of Yazoo and down to the beginning of the cut will be small, as the banks are generally above ordinary high water. Part of the spoil from the cut will be deposited on either side to raise the general level of the low land, and this will furnish material for parallel levees. With crowns of 6 feet and slopes one upon three, the average fill should not exceed 6 feet for all of the levees that possibly may be needed, for which $50,000 will be ample. These levees, with the fill on the left bank of the cut, may impound water and require drainage ditches to the bayous connecting with Lake Centennial, but considering the enhancement in value of the lands between Yazoo and the canal, the greater part of which are now subject to overflow at extreme high water, this work should be done by the owners; but in any case the cost will be small and hardly need be considered.

If the work should be done by contract a large force of inspectors would be required, and an engineering party kept in the field most of the time to measure the work done; and to cover such expenses, with those for office administration, etc., not less than 10 per cent of the estimates would be required.

The estimates in Assistant Engineer Marshall's report have been revised and checked, the final computations having been made with the rolling planimeter described in my report on Red River, but after careful study of them, the maps, and the country, I have thought it best to increase the amounts both to allow for excess of measurement in bank or scows over that in place, and also to leave margin for slips and fill and for enlarging the section of canal and basin. The allowance of 16 per cent given by Assistant Engineer Coppeé for difference between section and scow measurement in the Vicksburg Harbor work was obtained by careful computation, but it is smaller than usually estimated for, and if the excavation is to be made either by hydraulic methods or by dredges which require considerable water to carry off the material from the hoppers it should be not less than 25 per cent. I have also allowed 20 per cent for enlarging the cut from Old River to Lake Centennial and for contingencies. The proportions of section with slope of one upon two will give a discharge area sufficient for Yazoo, provided the banks will stand at that angle, but it will be cheaper to make the canal somewhat wider by successive rectangular cuts until the required depth is gained than to spend time upon trimming and grading the slopes, and let the slopes form themselves, the final bottom width and depth being the important features. I have therefore revised the estimates as for the full amount in scows or on bank for a rectangular cut of such width as to allow for transformation of vertical sides to slopes as great as one upon five, and yet leave a water line of not less than 50 meters width (say 150 feet) at zero of the gauge.

The width of the right of way is made greater (1,000 meters) than first proposed to give ample room for part of the spoil and the levees on either side of the canal. If a less width should be chosen, sufficient allowance might not be given for berm and for natural enlargement, and the probable small saving would be very much less than the amount that might be required for additional land for levees bought after the improvement.

To do the work by contract would require the full amount of the first estimate, less the first appropriation, to wit: $1,425,000 and increase the time for completion. Bidders must make large allowances for interest, insurance, accommodation, and delays before estimating their profits, all of which would be omitted in case the work were done by hired labor with plant and material owned by the United States. The possible delays and interruptions arising from re-advertising, failures, etc., as in the case of Philadelphia Harbor, cannot be estimated. Since the project contemplates postponing construction of dikes, dams, etc., and perhaps omitting them, the plant would be larger than I have estimated for that class of work, if required, since it cannot be done advantageously by contract. My estimates are for first-class dredges and appliances suited to the work proposed, purchase of fuel and supplies in large amounts in open market or by contract, good wages, lodging, subsistence, and medical and surgical attention, and prosecuting the work in 8-hour shifts without interruption (except between midnight of Saturday and midnight of Sunday), unless at extreme unfavorable stages, making all minor repairs to hulls, machinery, and tools at the fleet, care when laid up, engineering, administration, and contingencies.

### GENERAL ESTIMATES.

*Plant for canal.*

| | | |
|---|---|---|
| Dredges | $150,000 | |
| Dump scows | 45,000 | |
| Steamboats | 50,000 | |
| Coal barges | 36,000 | |
| Quarter and mess boats | 7,200 | |
| Machine-shop boat | 6,000 | |
| Storeboat | 1,200 | |
| Pumpboat | 1,000 | |
| Hospital boat | 2,000 | |
| Tools, rigging, skiffs, horses, wagons, etc | 4,000 | |
| | 270,000 | |
| Spare parts, renewals, repairs, care, etc | 30,000 | |
| | 300,000 | |
| Excavating and depositing 4,500,000 cubic meters, more or less, at 10c | 450,000 | |
| Total for dredging | | $750,000 |

*Additional plant for dams, etc.*

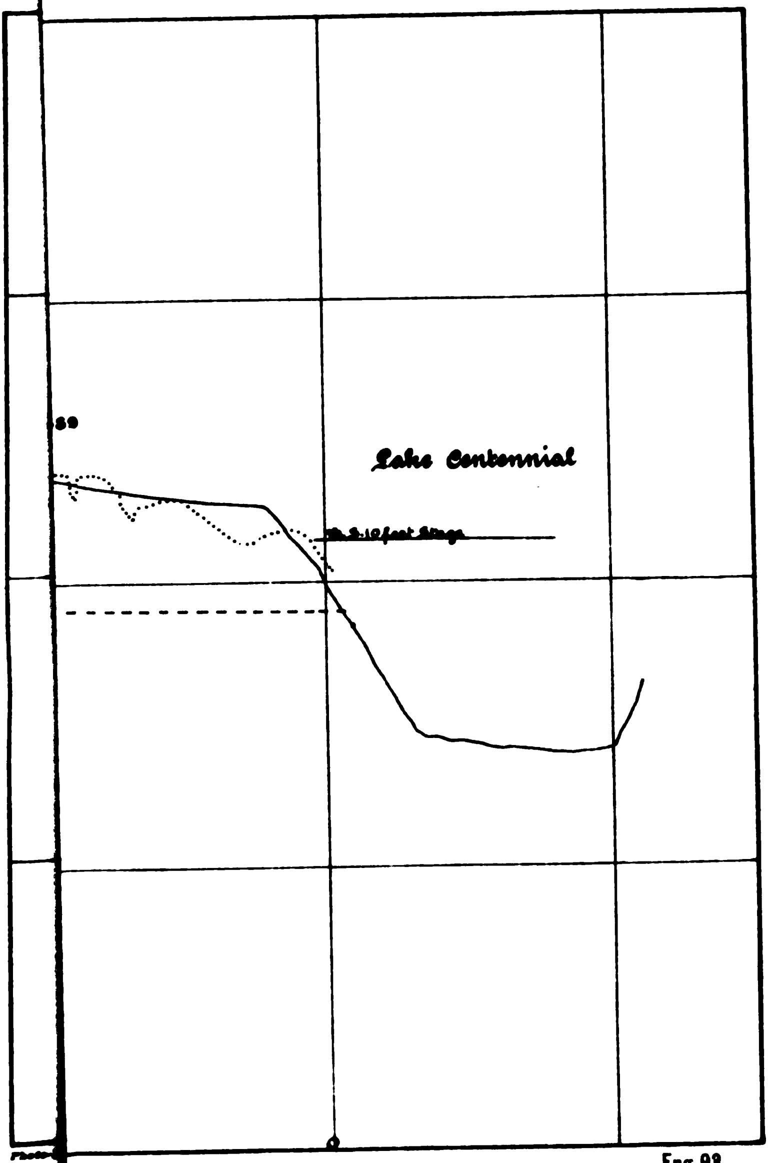
| | | |
|---|---|---|
| Pile-drivers | $8,000 | |
| Mattress boats | 7,000 | |
| Stone and brush barges | 24,000 | |
| Skiffs, tools, rigging, etc | 2,000 | |
| | 41,000 | |
| Spare parts, renewals, repairs, care, etc | 4,000 | |
| | 45,000 | |
| Brush, stone, wire, piling, etc., and labor on dams, levees, revetments, etc | 280,000 | |
| Total for construction | | $325,000 |
| Office charges, engineering, maps, administration, and contingencies | | 50,000 |
| Amount appropriated by act of July 13, 1892 | | 75,000 |
| Revised estimate | | 1,200,000 |
| Amount required to be appropriated to complete | | 1,125,000 |

The estimates of capacity are based upon one-third the reported amounts done by large dredges under average conditions; the working time of dredges is estimated at twenty-two days each month to allow for moving, breaking down, and repairs, and the minimum excavation is estimated at 220,000 cubic meters the month, with a probability of large increase. Carried on as outlined in three shifts daily, there will be required a force of about 250 men at a daily cost of $733.33, apportioned as follows: Wages, $435; subsistence, $75; fuel, $197; oil and waste, $26.33, or $22,000 the month, which, with the charges for office, engineering, and contingent account, will require an allotment of not less than $425,000 for the first year and $700,000, or so much thereof as needed, for the time remaining to complete. If it should be decided to have the work done by contract, $1,425,000 would be required, of which about $600,000 should be available for the first year; but it is my opinion that the method upon which I have based my estimates would be most economical and advantageous to the United States. Under favorable conditions the canal should be open to navigation in about thirty months from the date of the appropriation, on the assumption that six months will be required for delivery of the plant and a minimum excavation of 220,000 cubic meters the month, with a probability of reducing the time to two years. During the summer and autumn the subject of plant will be taken up and plans and specifications made, and probably the right of way will be bought and cession of jurisdiction obtained from the State of Mississippi. There is submitted an outline map showing the final route for the canal, with sketches of the early maps, showing the bends of Mississippi River before the cut-offs of about 1800 and 1876, and a drawing of the suspended pantograph. Assistant Engineer Marshall's report is given below.

*Money statement.*

| | |
|---|---|
| Amount appropriated by act approved July 13, 1892 | $75,000.00 |
| June 30, 1893, amount expended during fiscal year | 9,419.15 |
| July 1, 1893, balance unexpended | 65,580.85 |
| July 1, 1893, outstanding liabilities | 3.27 |
| July 1, 1893, balance available | 65,577.58 |
| Amount (estimated) required for completion of existing project | 1,125,000.00 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895 | 1,125,000.00 |

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.



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## REPORT OF ASSISTANT ENGINEER H. M. MARSHALL.

United States Engineer Office,
*Vicksburg, June 19, 1893.*

Captain: I have the honor to report on improvement of mouth of Yazoo River follows:

A quarter boat was towed from Barbre Landing, Louisiana, to Vicksburg, Miss., United States snag boat *Howell*, and repaired the latter part of September.

Beginning early in October, a small topographical party made a close stadia sur- y of that region between Lake Centennial and the Wrong End of Old River, rough which the most favorable route for a diversion canal must lie. Land records f the county were examined for descriptions of property lines and the owners' oundaries located on the ground. Preliminary lines were run for levees along the ute and prolonged up Old and Yazoo rivers as far as mouth of Steele Bayou. evels were run and high and low water gauge sections set at short intervals elow Yazoo and Mississippi Valley Railroad bridge. In connection with the pre- ise levels, of which more will be said presently, gauges were set at the railroad ridge, L'Argent, the junction of Big Sunflower and Yazoo rivers, and at Satartia. The gauges at Yazoo City and at Fort Loring, the Georgia Pacific Railway crossing, were connected with the system, and a gauge set on Big Sunflower at Baird Station, the Georgia Pacific Railway crossing of that river. The fieldwork is undergoing office computation, and the data can not yet be made public record, but enough is assured that will show a considerable "backing up" as far as Satartia and Baird by the floods in the Mississippi, thereby converting the comparatively steep low-water slope into almost no slope at high water. It is also well ascertained that there is a rapid divergence of the former and present high-water lines as they are traced upstream.

From the middle of November to near the end of January the field party was engaged running precise levels from the railroad bridge, to which point the line had been run in 1890, to Yazoo City. The two Kern precise level instruments, together with the rods, etc., imported by you for use on Red River Survey, were used, and the method of observing adopted on that work was adhered to. The line was run along country roads adjacent to the river and cut across points to save in distance. On account of the timber and the difficulty in moving the quarter boat upstream by hand, progress was not rapid, averaging 1.2 kilometers per day for the total time. The topography and property lines having been mapped to scale 1:5000 and a canal route selected, the party, after closing the precise levels at Yazoo City, returned to Old River and located the proposed cut. With grade 19 meters, Cairo datum, width on bottom 30 meters, side slopes 2 to 1, being the same dimensions used in the preliminary estimate (Report Chief of Engineers, 1892, p. 1640), the located line shows 2,645,196 cubic meters, against 3,408,705 cubic meters of the preliminary location, to be excavated between Old River and Lake Centennial. The estimated excavation in Lake Centennial, 675,140 cubic meters, will be reduced by the amount of dredging done in Vicksburg harbor improvement since 1890. By the courtesy of Assistant Engineer H. St. L. Coppeé, who has local charge of the last-named work, I have ascertained that amount of dredging to be 297,498 cubic meters, and total dredged in that work 949,489 cubic meters, at a cost of $157,125.33. The quantities are for scow measure, and cost is the amount paid to contractors. Mr. Coppeé estimates 16 per cent reduction, for this material from scow to place measurement. This leaves 3,070,538 cubic meters to be excavated, against 4,083,845 cubic meters stated in the preliminary estimate for this entire route. Profile shows comparison of preliminary and final location. No boring was done along the route because shortly after the return of the quarter boat to Old River the swamp became flooded by overflow. An experiment was made, using the United States snag boat *Meigs* in pulling the trees to clear the route of growing timber. The feasibility of the method was clearly demonstrated with trees of medium size, and the economic feature alone remains questionable.

On completion of the canal location the party was transferred to Greenville, Miss., and ran precise levels via Greenwood, from U. S. Coast and Geodetic Survey P. B. M. 1 to close on the line heretofore run to Yazoo City. The progress on this route was 1.5 kilometers per day. Discharge measurements were made as follows: Once near the mouth of Yazoo; once at Yazoo City; once a short distance below; and twice in the mouth of Big Sunflower, and in Yazoó just above and below there. The following table gives the discharge:

*Discharge observations.*

| Locality. | Date. | Areas. | Maximum mid-depth velocities. | Discharge. | Elevation water surface.* | Elevation water at Vicksburg. |
|---|---|---|---|---|---|---|
| | | *Square meters.* | *Meters.* | *Cubic meters.* | | |
| Old mouth of Yazoo | Oct. 22, 1892 | 341 | 0.82 | 157 | 21.9 | 20.07 |
| Yazoo below mouth of Sunflower | Jan. 25, 1893 | 1,011 | 1.06 | 856 | .......... | .......... |
| Yazoo below mouth of Sunflower | June 3, 1893 | 1,779 | 0.59 | 687 | .......... | .......... |
| In mouth of Sunflower | Jan. 25, 1893 | 546 | 0.56 | 221 | 29.55 | 22.51 |
| In mouth of Sunflower | June 3, 1893 | 1,302 | 0.07 | 47 | 34.97 | 34.25 |
| Yazoo above mouth of Sunflower | Jan. 25, 1893 | 609 | 1.17 | 577 | .......... | .......... |
| Yazoo above mouth of Sunflower | June 3, 1893 | 1,027 | 0.53 | 346 | .......... | .......... |
| Rialto Place | Jan. 4, 1893 | 684 | 1.20 | 657 | 32.7 | 26.33 |
| Yazoo City | May 26, 1893 | 1,129 | 0.82 | 675 | 36.25 | 34.58 |

* Elevations from preliminary computation.

Three large map sheets, scale 1:5000, showing the location of all contemplated work are in course of preparation. The detail features in the immediate vicinity have been plotted, and the more remote portions taken from the former survey maps, scale 1:10,000, by enlarging with the suspended pantograph imported by you. I herein embody your translation of the maker's description and instructions for using the pantograph, as a help to the engineering world to a just appreciation of the best form of this useful aid to a draftsman.

### DESCRIPTION OF CORADI'S SUSPENDED PANTOGRAPH NO. 532, WITH PLATES.

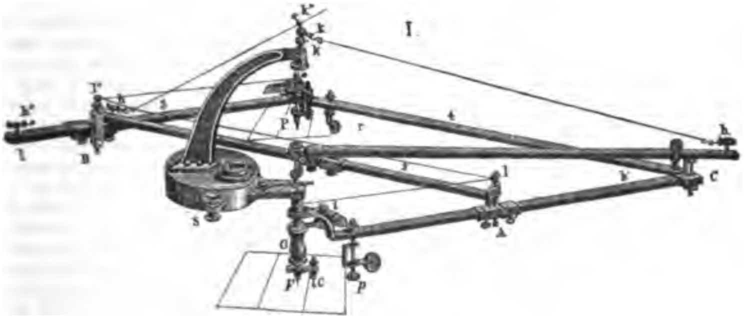
"This instrument is known as Pantograph No. 1, and consists of a parallelogram of three square tubes closed by a fourth square tube hinged to square sleeves that slide on the two opposite tubes. The sliding tube and the two adjacent are graduated to millimeters from zero points, fixed by the maker so that the settings shall correspond to the proper points of the true parallelogram formed by imaginary lines passing through the axes of the hinges connecting the four tubes. A fifth tube of cylindrical form incloses the neck of the polar axis and passes under a grooved roller swiveled underneath the outer end of the nongraduated tube. This supporting tube lies parallel to the latter for 'pole at end,' and follows the pole when shifted to 'pole at middle.' The formula for 'pole at end' is $X = L\frac{m}{n}$, in which X is the setting for the required ratio, $m$ and $n$ the fractions expressing the scales of the original and required drawings, and L the length of the side of the imaginary parallelogram, corresponding in this instrument to arm length 960 millimeters. The graduation extends to 670 millimeters, and the verniers read to one-tenth millimeter by slow-motion screws. The tubes are also graduated to exact settings for the usual ratios from 1:20 to 2:3 for the position pole at end, but since the drawing would be too near the pole beyond the ratios 2:3, pole at middle is used for 2:3 to 1:1 to 3:2, with formula $X = L\frac{m}{m+n}$. Pole stem, pencil, and tracer, are interchangeable in their sockets, so that by the two positions, reducing, copying, and enlarging are possible in all scales within the practical limits of the instrument. The position 'pole at end' allows the draftsman to follow both drawings with the eye without shifting position; but with 'pole at middle' the drawing and the tracing are inverted and on opposite sides. This interchanging of parts, with the two positions of the pole, makes it unnecessary to graduate much beyond two-thirds L, or 670 millimeters.

"To insure precision, the formulas may be used to test the set graduations, and the settings may also be corrected by actual measurement of lines scaled off to the true ratios.

"The support consists of a cast-iron base with a hemispherical socket for the ball of the pole stem, a clamp to pass over the neck of the latter, a cross level and two thumbscrews for leveling the base, and a curved arm rising from the base and projecting over the socket, so that when the base is level the line from the center of the socket through the arm center shall be vertical. The arm is terminated by a long spindle with two shoulders carrying brass swinging eyebars and ending in a small brass sphere. The parallelogram has three turn-buckles with rings, brass suspension wires to connect them with the eyebars to suspend the instrument from the standard after the pole has been put in the socket. One of the wires has an adjustable clamp with metal hemispherical socket to slip over the ball on top of the spindle, this ar-

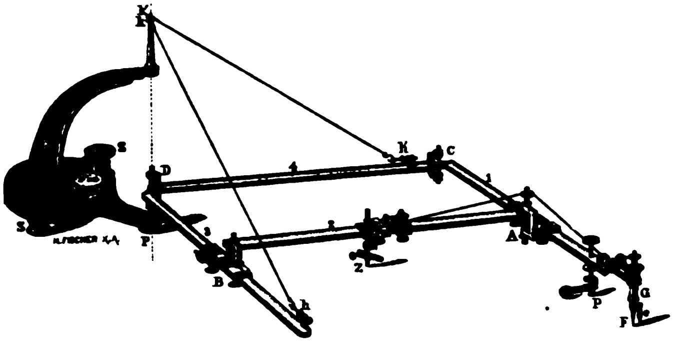
# Yazoo River Survey

## Suspended Pantograph.



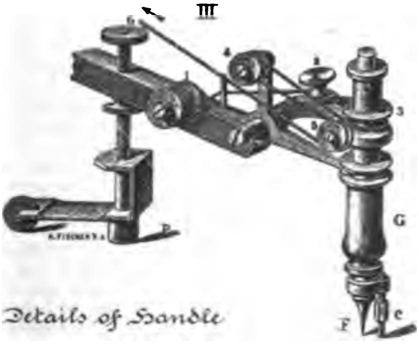
Pole at Middle

II.



Pole at End.

III



**Note:** Supporting tube now put underneath for both positions.

Photo-Lith. by A. Hoen & Co. Baltimore, Md

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rangement being required to adjust the length of the wire for any setting with 'pole at middle.' A small striding level is used to adjust the cross level and to make the parallelogram horizontal when set up for use. There are two casters adjusted by set-screws above and below the bars after the instrument is made horizontal. The handle has a double-curved surface, is hollow, and slides on the tracer-socket, being held up by a spring when not in use. The pencil is always raised from the paper when not in use by a cord passing over and under a combination of small sheaves and secured to the handle, so that the pencil falls as the handle is pressed down. For enlarging with 'pole at end' a short extra cord is put on to produce the same effect when pencil and tracer are intercharged. The pencil-holder will take Faber's prepared leads; the clamp for the holder has an arm with two holes for the necessary cord for the different positions of the pencil, whether at end or middle. There is a right-line pen which may be used for the pencil after the operator has become expert in handling the instrument. There are two points for adjustment and testing and for plotting points, and the tracer point may be pressed down by the finger independent of the handle. There is a small stem with three brass discs to weight the pencil and pen if necessary.

"*Instructions.*—First, note the position of the pantograph in its box. All the verniers are set to 1:2, 1:1, 'pole at end,' pencil at middle, tracer in front, and parallelogram shut up so that pole, pencil, and tracer are in the middle of the box, the end of the supporting tube and the contiguous hinge at the right hand end and the open end of the pole bar at the left. The small level is set in its place with feet against the side of the box, the wires clamped in place in the top of the box, the pen and pricking points in their proper holes, the pencil and tracer set up and clamped, and short stem with weights in place on the crossbar at the right hand. The box should be kept closed, hooked, and double locked. Whenever the instrument is to be returned to the box the verniers must be set as stated so that the parallelogram shall close to the described position. Use great care in handling, keep instrument clean, and oil the stems of pole, pencil, and pen occasionally. Use a camel's hair brush for dusting, and watch oil for the joints and stems. A chamois with a little jeweler's rouge may be used to rub the bright parts. In damp climate the instrument should be covered with oil when laid up, and wrapped in oiled paper or silk. A small box, with perforated lid, containing calcium chloride may be used for a day or to to dry the air in the box.

"The table should be made with the same care that is used for a first-class drawing board. It should be about 2 meters square and of such adjustable height that than an operator may sit or stand and work without special fatigue. If the feet are fitted with leveling screws and a footplate used the table may be made horizontal. The surface should be smooth and without cracks.

"For ratios $\frac{m}{n}$, the position 'pole at end' or 'pole at middle' will be determined by the size of the drawings, and also whether reduction or enlargement is desired, the object being to get the best results conveniently. Practical use will alone determine the best position. The position 'pole at end' has this advantage, that the drawing and tracing being on the same side and the motion of pencil and tracer in the same direction both are convenient to the operator's eye, either for enlarging or reducing, while the motion is inverted for the position 'pole at middle' for either. For the position 'pole at end' the standard should be placed near the middle of the side of the table, both to avoid frequent changes of position and also that the tracer shall not run off at extreme positions. For the position 'pole at middle' the standard is put about the middle line of the table with the line joining the thumbscrews, making an angle of about 45° with the side. For either position set the standard first, and, the table being fairly horizontal, make the standard axis vertical by means of the cross level and thumb screws. Place padded blocks or books on the table to support the pantograph near the joints to avoid strains; take the pantograph from the box, open it out, and put the pole near the standard and set the verniers to the required ratio for X. Take off the nongraduated bar carefully, fit the pole in the socket, and suspend the outer end to the standard by means of the long wire; set the level on the bar, bring bubble to center by means of the turn-buckle, and swing the bar. If the bubble remains at center, the axis is vertical; if not, make corrections by the small screw on the crosslevel and the turn-buckle and repeat. When the cross level has been adjusted the axis will then be vertical. The level ought not to get out of adjustment, but it is well to test it occasionally. Replace the bar, set the pole in the socket, and slip the clamp over it. Attach the short wire to the lower eyebar of the standard and to the turn-buckle of the open graduated arm of the pantograph, and the long wire to the upper eyebar and to the turn-buckle on the cylindrical tube, and make the bars horizontal by means of the buckles and the small level; then adjust the casters by their opposite thumbscrews. Two or three trials may be necessary.

"The cord should be adjusted so that the pencil and tracer shall just clear the paper when free, the stop at the tracer being adjusted so that the point shall not touch the paper when the handle is pressed down. Place the sheets in convenient positions, secure one corner of each and fix the other by a straight edge, and then fasten down both sheets by small thumb tacks. For enlarging with "pole at end," exchange pencil holder and tracer point, but guide the instrument by the handle as in reducing, using the short piece of cord in addition to the long cord, following it as far as the sheave on the handle, but then down to the clamp below; the pencil will then rise when free. For "pole at middle," take out the pencil holder and remove the pole stem and cylindrical bar and place in the socket for pencil. Set for the second formula for ratios 2:3 to 1:1 to 3:2. Pencil and tracer are interchangeable for reducing or enlarging.

"The axis being vertical and the instrument set as before, put the pole in socket, clamp, and hook the long wire to the turn-buckle on the end of the cylindrical tube and to the upper eyebar of the standard, and level by the small level and thumb-screws. Take the wire with the clampblock and hook to the turn-buckle on the middle bar, slip the block over the brass knob on top of the standard, and adjust the length approximately by slipping the wire through the block and clamp. Make the middle bar horizontal. Make the tracer bar horizontal by the level and the caster screws, and do the same for the bar parallel to the middle bar, then readjust the wires; the instrument should then swing on a horizontal plane. Reductions and enlargement are effected by interchanging the pencil and tracer. The cord is fixed in the same way at the tracer end, but must be passed around the sheave on the opposite bar in the same direction as around the sheave at the junction of the tracer and middle bar, so as to remain at a constant length for the given setting. When the instrument is to be put away, set all the verniers at 1:2, 1:1 close up and put in the box as described in the positions to be noted."

As soon as the stage of the river permits, borings will be made along the line of the proposed canal, after which nothing will remain to be done, except the purchase and clearing of the right of way, before letting the contract for the excavation. No detail estimate is submitted, as it seems certain the work can be completed well within the original estimate, and it may prove more desirable to increase the dimensions rather than decrease the cost of the cut.

Very respectfully, your obedient servant,

H. M. MARSHALL,
*Assistant Engineer.*

Capt. J. H. WILLARD,
*Corps of Engineers, U. S. A.*

## V 11.

## IMPROVEMENT OF TCHULA LAKE, MISSISSIPPI.

Tchula Lake or River is the name given to the east and narrowest branch of the Yazoo River, where it divides in passing Honey Island. It is wholly within Holmes County, Miss., and is about 60 miles long. Honey Island is about 100 miles above the mouth of Yazoo River, and fertile plantations join each other along its banks, their annual product being estimated at about 20,000 bales of cotton. When the water is high enough to enable the Yazoo and Tallahatchee steamboats to cross the bars they make trips through the lake.

In accordance with requirements of river and harbor act of March 3, 1879, an examination of the lake was made that year with a view to its improvement, and the principal obstructions to navigation were found to be snags and logs in the lower part and leaning timber and shore snags along both banks, from the head to the foot of the island. The project contemplated removing these obstructions to permit light-draft boats to enter the lake earlier in the season, and the estimated cost was $10,000, if done in one low-water season. (Report Chief of Engineers, 1880, pp. 1350, 1351.) The work is of such nature that it must be gone over to remove obstructions that are added from time to time.

The appropriations have been as follows:

| By act of— | |
|---|---|
| March 3, 1881 | $3,000 |
| August 2, 1882 | 2,500 |
| July 5, 1884 | 1,500 |
| August 5, 1886 | 2,000 |
| August 11, 1888 | 3,000 |
| September 19, 1890 | 3,000 |
| July 13, 1892 | 3,000 |
| Total | 18,000 |

Operations have been carried on by hired labor. Work commenced at the head of the lake July 16, 1881, was carried down to the foot, suspended September 8, 1881, and consisted of cutting and girdling leaning timber and removing the worst snags. It was resumed at the mouth September 1, 1882, and carried up to the head of the lake and suspended the middle of November, 1882. Nothing was done the following season, as no funds were available, but December 22, 1884, work was resumed at the head of the lake and carried down to the foot, and suspended February 11, 1885. The next work was done by the United States snag boat *Meigs*, which was employed December 19–25, 1886, and April 11–30, 1887, in removing the heavier obstructions and clearing a good navigable channel 90 feet wide for a distance of 44 miles. February 1–19, 1889, the *Meigs* was employed again, and worked from the foot to the head of the lake and back, removing the heavier obstructions, after which operations were suspended until the water should fall sufficiently for a chopping party to commence clearing the banks; but as a favorable opportunity for advantageous expenditure of the small balance available was not presented during the following season, nothing was done until December 10, 1890, when the *Meigs* was used for the succeeding ten days in removing snags, tree slides, etc., from the channel. August 18, 1891, a chopping party commenced work at the head of the lake, and continued downstream to Dunbarton, about 15 miles above the mouth, where it was suspended December 16, 1891, the available funds being exhausted. Operations during this period consisted of clearing the brush, which had grown so rapidly and to such extent that in many places the channel did not exceed 50 feet in width, cutting shore snags and logs, felling and girdling leaning timber on both banks, and removing snags from the channel.

No work was done during the fiscal year ending June 30, 1893. It is intended to resume operations as soon as the water falls to a low stage, applying the funds available to the removal of snags and logs in the channel and leaning timber and brush along the banks, and to build inexpensive wing dams at the bars with the material cut. Operations should extend from the foot to the head of the lake, as new obstructions are added every year.

The work done has resulted in giving greater ease and safety to the passage of boats, but the period of navigation has not been prolonged; in fact, it is reported that the bars at the head of the lake and below Marcella to the mouth of Black Creek are enlarging gradually, and each year it requires a little higher stage of water to enable boats to pass through the lake. Brush or light pile dams at the bars can be built at little expense and a considerable increase of depth obtained. The clearing of the banks should be carried out systematically, and by the expenditure of $6,000 in one low-water season can be completed so that further work would not be necessary for several years.

### *Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $29.41 |
| Amount appropriated by act approved July 13, 1892 | 3,000.00 |
| | 3,029.41 |
| June 30, 1893, amount expended during fiscal year | 83.23 |
| July 1, 1893, balance unexpended | 2,946.18 |
| July 1, 1893, outstanding liabilities | 9.00 |
| July 1, 1893, balance available | 2,937.18 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895 | 6,000.00 |
| Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893. | |

## COMMERCIAL STATISTICS.

The lake was reported navigable for a period of four months during the fiscal year.

*List of stern-wheel steamboats that navigated Tchula Lake in the fiscal year 1893.*

| Name. | Tonnage. | Length. | Breadth. | Depth. | Draft. | | Round trips. | Passengers. |
|---|---|---|---|---|---|---|---|---|
| | | | | | Light. | Loaded. | | |
| | | *Feet.* | *Feet.* | *Feet.* | *Ft. in.* | *Ft. in.* | | |
| Addie E. Faison | 241.50 | 135 | 30.6 | 4.9 | 2 2 | 5 0 | 8 | 40 |
| Blanks Cornwell | 232.40 | 140 | 29 | 4.6 | 2 3 | 5 2 | 60 | 201 |
| Birdie Bailey | 109.74 | 111 | 22 | 3.5 | 1 10 | 4 0 | 10 | 60 |
| H. M. Townsend* | 89.70 | 116.7 | 18 | 3.1 | | | 2 | |
| Bertha C. (tug) †* | | | | | | | | |

* With barges. † No report.

*Summary of commerce reported.*

| Article. | 1892-'93. | 1891-'92. | 1890-'91. |
|---|---|---|---|
| | *Tons.* | *Tons.* | *Tons.* |
| Cotton | 1,805 | 1,350 | 1,500 |
| Cotton seed | 1,095 | 2,505 | 2,100 |
| Live stock | 26 | 24 | 27 |
| Lumber | 1,270 | 1,460 | 1,230 |
| Staves | | | 3,615 |
| Provisions | 815 | 1,055 | 500 |
| Grain | 310 | 1,110 | 600 |
| Miscellaneous | 750 | 1,360 | 700 |
| Total freights | 6,078 | 8,864 | 10,272 |
| Estimated value | $243,000 | $537,000 | $492,000 |

The Yazoo branch of the Illinois Central Railroad from Parsons, on the Yallabusha, to Jackson, Miss., runs parallel to the lake, and also has a tap line from Tchula to the main line at Durant, and has diverted a large amount of the business formerly done by steamboats.

## V 12.

## IMPROVEMENT OF TALLAHATCHEE RIVER, MISSISSIPPI.

The headwaters of Tallahatchee River are in Tippah County, in northern Mississippi, whence it flows in a general southwesterly direction through the counties of Union, Lafayette, Panola, joins Coldwater River in Quitman, and then, as the main stream, flows in a southerly direction through Tallahatchee and LeFlore counties, and unites with the Yallabusha in forming Yazoo River.

Under river and harbor act of June 18, 1878, an examination was made that year, and the project based thereon contemplated improvement of low-water navigation of the river from its junction with the Coldwater to the mouth, a distance of about 100 miles, by removal of snags, sunken logs, and leaning timber, and the wreck of the steamer *Star of the West*, 8 miles above the mouth. The estimated cost of the work was $40,000, if completed in two consecutive low-water seasons. (Report Chief of Engineers, 1879, pp. 982–986.)

The following appropriations have been made:

| By act of— | |
|---|---|
| March 3, 1879 | $6,000 |
| June 14, 1880 | 9,000 |
| March 3, 1881 | 3,000 |
| August 2, 1882 | 3,000 |
| July 5, 1884 | 3,000 |
| August 5, 1886 | 3,500 |
| August 11, 1888 | 5,000 |
| September 19, 1890 | 5,000 |
| July 13, 1892 | 5,000 |
| Total | 42,500 |

By the terms of the acts, $5,000 of the appropriation of 1880, $2,000 of the appropriation of 1881, and all of the appropriation of 1882 were required to be expended above the mouth of Coldwater to Batesville, in the part known as the Little Tallahatchee, which was not included in the original project or estimate of cost.

The improvement was commenced at the mouth September 18, 1879, by the United States snag boat *Florence*, carried upstream to within 20 miles of Sharkey Landing, and suspended November 20, 1879. Operations during this period consisted of the removal of leaning timber, which obstructed navigation at all stages. Work with the *Florence* was resumed the latter part of August, 1880, at Pecan Point, continued down to the mouth, and suspended October 18, 1880. For the stretch of river above mouth of Coldwater to Batesville a flatboat was built and fitted up with necessary machinery, and work commenced early in October, 1880, at the mouth of Coldwater, continued upstream to Batesville, and was suspended at the close of January, 1881. Operations consisted of removing snags, logs, leaning timber, rafts, and drift piles. This work was resumed at Batesville June 4, 1881, and between that date and August 9, 1881, was carried down to mouth of Coldwater. During this period the river was very low, and in places blocked with drift, through which a channel was cut wide enough for boats to pass at a good stage of water. From the mouth of Coldwater the boat dropped downstream, removing the principal obstructions, as far as practicable with the limited amount available, on the way, and thoroughly clearing a bad stretch of river near Pecan Point, complained of by steamboat men, after which work was suspended about the middle of September, 1881. Under the act of 1882 work was resumed at Batesville September 15, carried down to within 6 miles of the mouth of Coldwater, and suspended November 30, 1882. Owing to lack of funds nothing was done the following season, but from November 1 to December 6, 1884, the United States snag boat *Meigs* was employed in thoroughly clearing the obstructions in the lower part of the river for a distance of about 25 miles above the mouth. Work with the *Meigs* was resumed under the next appropriation December 1, 1886, but December 27 the boat was withdrawn on account of high water until May 11, 1887, after which work was continued until June 10, 1887, and carried from the mouth to Sharkey Landing before the funds were exhausted. No work was done the following year, no funds being available; but May 18–31 and June 13–17, 1889, the *Meigs* again worked over the lower river as high as Williams' wood yard, 18 miles below Sharkey, suspending operations the latter date on account of high water. November 8 to December 24, 1889, the *Meigs* was employed between the mouth and Cassity Bayou, one-half mile below Sharkey. Under the act of 1890 the *Meigs* entered this river November 1, 1890, and worked rapidly up to Sharkey Landing, as it was desired to carry operations to the mouth of Coldwater before the water should fall. The boat reached a point 6 miles above Sharkey November 7, but found the water too low to go farther and turned back, and was employed on the 40 miles below Sharkey until November 17. On the latter date a slight rise set in, and the work was carried up to Mead Landing, at the mouth of Tillatoba River, about 25 miles above Sharkey, until November 25, 1890. During the remainder of November the boat worked in the lower part of the river. Nothing further was done until June 15, 1891, when the *Meigs*, which had been working in the Yazoo, entered this stream and worked for six days removing tree slides, etc. During the month of October, 1891, the snag boat *Meigs* was employed in the lower 50 miles of the river until the funds available were exhausted. The water was at a low stage throughout the month and effective work was done.

The work from 1879 to the end of the fiscal year 1892 resulted in great benefit to navigation of the river below Sharkey Landing, enabling steamboats to run to the latter place the year round, while before the improvement commenced there was navigation for only about six months of the year. While the project contemplated work from the mouth up to the junction of the Coldwater and Little Tallahatchee, little was done above Sharkey Landing, for the reason that the available funds were not sufficient to extend operations farther, and because the steamboat interest reported that boats would not go above that landing except to make occasional trips into Coldwater River at high stages, when navigation was as good and about as safe as in the lower part of the stream. In 1890, however, the steamboat men requested that operations be extended above Sharkey to the forks.

The work in Little Tallahatchee River, above mouth of Coldwater to Batesville, resulted in no benefit to navigation or commerce, as there has been little or no trade in that part of the stream since the war.

The river and harbor act of July 13, 1892, provided that of the $5,000 appropriated for continuing improvement of Tallahatchee River, "$2,000 may be used in the improvement of said river between the bridge at Panola, Miss., and the mouth of the Coldwater River at the discretion of the Secretary of War." In my project of July 19, for expenditure of this appropriation, it was recommended that no money be expended above the mouth of Coldwater River for the following reasons, viz:

> Although the work in the lower river has been of much benefit to navigation from the mouth up to Sharkey Landing, the trouble has been that with the small amounts

appropriated nothing could be attempted beyond the removal of the worst obstructions. Maj. (now Lieut. Col.) Benyaurd estimated in 1879 that the obstructions below the mouth of Coldwater could be removed in two consecutive seasons of low water at a cost of $40,000, but the appropriations in fourteen years aggregate only $42,500, of which the law required $10,000 to be expended in this Little Tallahatchee River, which had not been examined and for which no recommendation had been made by the Department or the officer in charge. At the close of the last work done, in 1882, Maj. Benyaurd reported that: "On the stretch of river between Batesville and the mouth of Coldwater I do not think it advantageous, in a commercial view, to expend any more money. There has not been a boat on this section of the river since the war, and I doubt, even if the river was improved, that boats could be induced to run." The sum of $5,000 is not sufficient for the river below the Coldwater, my estimate for the fiscal year 1893 having been for $10,000, to permit the systematic clearing of the banks in addition to snagging operations. If $2,000 are allotted to the upper river, it will result in no benefit to commerce or navigation, as no boats run in that part of the stream, and it will reduce the amount for the lower river so that no practical benefit can be attained, and during the period of two years which probably will elapse before another appropriation is made, judging from the experience of the past decade, much of the results of the former work will be lost. Until the original project for improving the river to the mouth of Coldwater shall be completed, the question of extending the improvement up Little Tallahatchee should not be considered; and before any work is done there should be a preliminary examination to determine whether it is worthy of improvement, and the prospective commerce which by that time may be benefited.

Upon the recommendation of the Engineer Department, the Secretary of War, August 3, 1892, authorized the entire appropriation to be expended on the river below the mouth of Coldwater River.

During the fiscal year ending June 30, 1893, operations were continued as follows:

The United States snag boat *John R. Meigs*, P. R. Starr, master, after working to the head of Yazoo River, entered the Tallahatchee September 5, 1892, on a stage about 7 feet above extreme low water. All snags, logs, and other obstructions in sight were removed, and the drag chain was used freely at all bars and obstructed places. After working to a point 9 miles above Sharkey Landing, and finding the water too low to proceed further, the *Meigs* turned back, cutting leaning trees, shore snags, stumps, etc., on the way down, and reached the mouth of the river September 30. April 2, 1893, the *Meigs* left Vicksburg and entered Tallahatchee River and resumed operations April 6. Little work was found necessary below Sharkey Landing, but above that place the river was low and falling, and the boat pushed upstream as rapidly as possible with the intention of reaching the mouth of Coldwater River before the water should fall too much. On arriving at the mouth of Tillatoba Creek, about 25 miles above Sharkey, the river had reached a stage so low that it was deemed unsafe to go farther upstream, and April 9–11 the boat worked back to Sharkey Landing, cutting leaning timber and removing shore snags, etc. In the meantime a rise set in, and April 12–26 the boat was employed in removing obstructions in the stretch above Tillatoba Creek to mouth of the Coldwater. Numerous rafts of saw logs were encountered on the way, many of which had to be released from snags on which they had lodged before the *Meigs* could pass upstream. The rise continued, and the latter part of the month reached a stage too high to work to advantage, and the *Meigs* returned to Vicksburg April 30.

April 6, on the way up the river, the *Meigs* attempted to raise the wreck of the steamer *Lake City*, which sank near the railroad incline at Minter City August 26, 1892, but the hull was so rotten that it could not be saved, and after putting the engine, boiler, capstan, wheel, shaft, and part of the steam pipes on the bank, the hull was broken up, so as to be out of the way of passing boats.

The following is a summary of the work done during the year, viz:

| | |
|---|---|
| Snags pulled | 250 |
| Stumps pulled | 40 |
| Logs removed from the channel | 1,058 |
| Shore snags cut | 965 |
| Stumps cut | 462 |
| Leaning trees cut | 11,073 |
| Leaning trees topped | 286 |
| Trees girdled | 1,611 |
| Square yards willow and brush cut | 1,440 |

Wrecks removed, viz: Steamer *Lake City.*

Continued high stages during May and June prevented further work to the end of the fiscal year; but as soon as the water falls sufficiently operations will be resumed and continued until the small balance available is expended.

There can be no doubt that the work done has been of great benefit to navigation from the mouth to Sharkey Landing, but with the small amounts appropriated nothing could be attempted beyond the removal of the worst obstructions. In 1879 it was estimated that the obstructions below the mouth of Coldwater could be removed in two consecutive seasons of low water at a cost of $40,000. The appropriations during a period of 14 years aggregate $42,500, of which the law required $10,000 to be expended on a part of the river not included in the project. New obstructions are added every year by sliding and caving banks, and the shifting and scouring of the channel exposes others on the bottom, or lodges them upon the bars. A snag boat should be used each year to remove obstructions in the channel, but the appropriation should be large enough to permit the systematic clearing of the banks, and the sum of $10,000 can be expended to advantage in this way in one season of low water, and result in permanent benefit to navigation.

### *Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $18.52 |
| Amount appropriated by act approved July 13, 1892 | 5,000.00 |
| | 5,018.52 |
| June 30, 1893, amount expended during fiscal year | 4,071.08 |
| July 1, 1893, balance unexpended | 947.44 |
| July 1, 1893, outstanding liabilities | 17.50 |
| July 1, 1893, balance available | 929.94 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895<br>Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893. | 10,000.00 |

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COMMERCIAL STATISTICS.

This river was navigable to Sharkey Landing the entire year, and at high stages boats ran to Mead Landing, at mouth of Tillotoba Creek, and occasionally into Coldwater River.

*List of steamboats that navigated Tallahatchee River in fiscal year 1893.*

| Name. | Class. | Tonnage. | Length. | Breadth. | Depth. | Draft. |  | Between— | Round trips. | Passengers. |
|---|---|---|---|---|---|---|---|---|---|---|
|  |  |  |  |  |  | Light. | Loaded. |  |  |  |
|  |  |  | *Feet.* | *Feet.* | *Feet.* | *Ft. in.* | *Ft. in.* |  |  |  |
| Addie E. Faison | Stern-wheel. | 241.50 | 135 | 30.6 | 4.9 | 2 2 | 5 0 | Mouth and Sharkey | 14 | 10 |
| John F. Allen | ..do | 133.90 | 130.2 | 24 | 4.2 | 1 8 | 4 0 | ......do | 20 | 38 |
| Blanks Cornwell | ..do | 232.40 | 140 | 29 | 4.6 | 2 3 | 5 2 | ......do | 4 | 10 |
| Lake City | ..do | 35.80 | 75 | 16.6 | 4.6 | 1 4 | 3 2 | ......do | 26 | 110 |
| Ike Bonham | ..do | 78.52 | 95.4 | 18 | 3.6 | 1 8 | 3 6 | ......do | 41 | 122 |
| H. M. Townsend* | ..do | 89.70 | 116.7 | 18 | 3.1 | ...... | ...... | Mouth and Coldwater River. | 5 | .... |
| Huston Combs No. 2.* | ..do | 95.96 | 98 | 22 | 3.4 | 3 0 | 4 0 | ......do | 6 | .... |
| John M. Abbott | ..do | 97.78 | 92 | 20 | 3.6 | ...... | ...... | Mouth and Sharkey † | .... | .... |
| Ferd R | ..do | 30 | ...... | ...... | ...... | 1 0 | 3 0 | Mouth and Wolf Lake.<br>Mouth and Coldwater River. | 15<br>10 | ....<br>.... |
| Bertha C* † | Tug | ...... | ...... | ...... | ...... | ...... | ...... |  | .... | .... |

* With barges. † No report.

*Summary of commerce reported.*

| Articles. | 1892-'93. | 1891-'92. | 1890-'91. |
|---|---|---|---|
|  | *Tons.* | *Tons.* | *Tons.* |
| Cotton | 3,141 | 5,588 | 4,000 |
| Cotton seed | 4,400 | 8,257 | 6,000 |
| Hides and skins | 3 | 53 | 5 |
| Live stock | 30 | 31 | 32 |
| Lumber | 1,300 | 1,188 | 1,424 |
| Staves | 3,447 | 3,204 | 9,245 |
| Provisions | 3,450 | 5,571 | 4,200 |
| Grain | 1,800 | 5,725 | 4,800 |
| Saw logs | 26,700 | 24,473 | 19,000 |
| Miscellaneous | 4,100 | 6,329 | 5,000 |
| Total freights | 48,371 | 60,419 | 53,706 |
| Estimated value | $908,000 | $2,428,000 | $2,115,000 |

The Yazoo and Mississippi Valley Railroad has a branch line from Clarksdale, Miss., to Minter City, on the Tallahatchee, which will be extended to connect with the Georgia Pacific near Greenwood, and the Georgia Pacific and Illinois Central railroads at Greenwood are competitors for the trade of Tallahatchee River.

## V 13.

## IMPROVEMENT OF STEELE AND WASHINGTON BAYOUS, MISSISSIPPI.

Steele Bayou has its source in Swan Lake, in Washington County, Miss.; flows in a general southerly direction, forming the outlet of Lake Washington, with which it is connected by Washington Bayou, a stream about 7 miles in length, and enters Yazoo River about 12 miles above its mouth. Its course is parallel to the Mississippi and its length about 85 miles; the fall is slight and the stream is not navigable, except when the Mississippi is high enough to fill the lower portion with back water.

An examination of Steele Bayou from its mouth to Swan Lake was made under river and harbor act of August 2, 1882, and in January, 1883, the officer in charge reported adversely to the improvement. (Report Chief of Engineers, 1884, pp. 1360–1362.)

The following appropriations have been made, viz:

| By act of— | |
|---|---|
| July 5, 1884 | $2,500 |
| August 5, 1886 | 2,500 |
| August 11, 1888 | 2,500 |
| September 19, 1890 | 2,500 |
| July 13, 1892 | 2,500 |
| Total | 12,500 |

The act of 1884 provided for improving Steele Bayou alone; Washington Bayou has been included in subsequent appropriations. The project contemplates removing snags, stumps, drift, and leaning timber to improve high-water navigation.

Work with a chopping party was commenced at the foot of Swan Lake November 1, 1884, was carried down to the mouth of the bayou and suspended February 11, 1885, and consisted of the removal of the principal obstructions only. It was resumed November 1, 1886, at the head of Washington Bayou, continued down Steele Bayou about 40 miles, and suspended early in January, 1887, by high water. Nothing was done the following season, as the unexpended balance was not sufficient to resume work. February 11, 1889, a steamboat was hired, and employed for 16 days in removing obstructions below the mouth of Washington Bayou down to within 8 miles of the mouth, and was then withdrawn on account of high water. July 12–17, 1889, a light-draft steamboat was employed to remove obstructions from Bon Eagle Plantation down to the mouth, about 22 miles, Under the act of 1890, the United States snag boat *Florence* was sent into Steele Bayou February 8, 1891, and worked until the end of that month, when it was withdrawn on account of high water. Operations extended from the mouth up to the foot of Poindexter Island, about 50 miles. December 21, 1891–February 12, 1892, a chopping party carried work from the mouth upstream about 22 miles before the available balance was exhausted.

From 1884 to the end of the fiscal year 1892 Steele Bayou was worked over twice from Swan Lake to the mouth, and the obstructions in Washington Bayou were removed in 1886, resulting in greater ease and safety to steamboat navigation at high stages, but operations were by no means thorough on account of the small appropriations.

No work was done during the fiscal year ending June 30, 1893, as the season of low water was short and the available plant was needed on works of greater importance. As soon as practicable a chopping party will resume the work of removing obstructions to high-water navigation, and continue until the funds available are exhausted.

The region bordering the upper part of Steele Bayou and Washington and Swan lakes furnishes the principal products. The lower part of the bayou is subject to overflow from backwater, and not much land in the vicinity is cultivated. The west side of Lake Washington is near the Mississippi, and a loop line of the Yazoo and Mississippi Valley Railroad, from Coahoma to Rolling Fork, passes between Swan Lake and Lake Washington, and diverts the main traffic from the bayou before navigation opens. Steamboat navigation in Steele Bayou was not commenced until 1879, and since the construction of the railroad in 1884 it has decreased steadily, until for several years past the trade has amounted to little or nothing. In view of the limited commerce to be benefited and the cost of maintaining the work by the removal of new obstructions added from time to time, it is not believed that any further amount can be expended profitably for the improvement of this stream, and estimates for that purpose are omitted.

*Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $12.67 |
| Amount appropriated by act approved July 13, 1892 | 2,500.00 |
| | 2,512.67 |
| June 30, 1893, amount expended during fiscal year | 69.10 |
| July 1, 1893, balance unexpended | 2,443.57 |
| July 1, 1893, outstanding liabilities | .31 |
| July 1, 1893, balance available | 2,443.26 |

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COMMERCIAL STATISTICS.

The bayou is regarded navigable only when the Vicksburg gauge reads 33 feet or above. During the fiscal year the river was at or above that stage July 1 to August 3, 1892, and February 23 to June 30, 1893.

One stern-wheel steamboat, the *Dyersburg*, 73 tons, made two trips from Vicksburg into the bayou to Magnolia and to Many Place.

*Summary of commerce reported.*

| Articles. | 1892-'93. | 1891-'92. | 1890-'91. | 1889-'90. |
|---|---|---|---|---|
| | *Tons.* | *Tons.* | *Tons.* | *Tons.* |
| Cotton | | 9 | 1 | 8 |
| Cotton seed | 70 | 190 | 50 | 346 |
| Saw logs | 600 | 1,335 | 150 | |
| Miscellaneous | | 50 | 125 | |
| Total down freight | 670 | 1,584 | 326 | 354 |
| Return freight | | 100 | 300 | 350 |
| Total | 670 | 1,684 | 626 | 704 |
| Estimated value | $4,000 | $10,000 | $16,000 | $50,000 |

The branch of the Yazoo and Mississippi Valley Railroad referred to in this report has diverted traffic from the bayou, and owing to the uncertainty of navigation there is no probability that any portion of the trade will be revived.

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## V 14.

## IMPROVEMENT OF BIG SUNFLOWER RIVER, MISSISSIPPI.

Big Sunflower has its source in Mud Lake, Coahoma County, Miss., 2½ miles from Friar Point, on the Mississippi, flows in a general southerly direction, and enters Yazoo River about 45 miles above its mouth. During extreme high water it is navigable to Clarksdale, about 280 miles above the mouth; but Faisonia, about 144 miles above the mouth, ordinarily is considered the head of navigation.

Under river and harbor act of June 18, 1878, an examination of this river was made, and the project based thereon contemplated the removal of snags, sunken logs, and leaning timber obstructing navigation, and building wing dams to scour a channel from 3 feet to 40 inches deep through Oliphant Bar and Muscle Shoals, at an estimated cost of $66,000. Oliphant Bar begins at the mouth of the river and extends upstream 15 miles; Muscle Shoals begin about 38 miles above the mouth and extend upstream about 5 miles. (Report Chief of Engineers, 1879, pp. 982–984.)

The following appropriations have been made:

| By act of— | | By act of— | |
|---|---|---|---|
| March 3, 1879 | $20,000 | August 11, 1888 | $5,000 |
| June 14, 1880 | 8,000 | September 19, 1890 | 5,000 |
| March 3, 1881 | 4,000 | July 13, 1892 | 5,000 |
| August 2, 1882 | 5,000 | | |
| July 5, 1884 | 5,000 | Total | 62,000 |
| August 5, 1886 | 5,000 | | |

The improvement commenced in the fall of 1879. A light-draft steamboat was chartered September 11 and employed until November 27, 1879, in removing snags, logs, etc.; building ten wing dams at Oliphant Bar, which increased the depth of water to 3 feet where there had been but 18 inches, and three wing dams at Muscle Shoals. These dams were inexpensive structures of light piles and brush, but answered the purpose for which intended. Work was resumed June 19, 1880, with a light-draft steamboat, hired for the purpose, and continued until December 4, 1880, when it was suspended by high water. During this period operations were carried from the mouth up to Faisonia, and consisted of removing snags and logs from the channel, leaning timber along the banks, and building wing dams at Callao and Vick Landing, which increased the depth of channel from 18 inches to 3½ feet. The next season a chopping party commenced the removal of leaning timber and snags at Clarksdale June 10, 1881. This work was carried downstream until June 24, when the party was moved down to Faisonia, where operations ceased in 1880. From June 29 to September 15, 1881, work was carried from Faisonia upstream to Dougherty Ferry, after which the force was transferred to the lower river and employed in removing obstructions, repairing the dams at Callao and Vick Landing, and building new dams at Shell Ridge, until work was suspended by high water October 27, 1881. In 1882 a chopping party commenced work, August 26, and continued until the latter part of January, 1883, from Standing Stump upstream to Clarksdale, including all the upper river that had not been worked over previously. Nothing was done the following season, as no appropriation was made. Under the act of 1884 a light-draft steamboat was chartered October 12 and employed in the lower river until December 21, 1884, removing snags, logs, etc., and building and repairing wingdams where needed. This work was supplemented by operations of the United States snag boat *Meigs* January 1–18, 1885. From June 14 until August 26, 1887, operations were continued below Faisonia by means of a light-draft steamer, hired for the purpose, and a force of 25 to 30 men, removing obstructions from the channel and building wing-dams where needed at the shoals. June 7 to July 7 and September 1 to 9, 1889, a steamboat was employed in going over the work below Faisonia removing obstructions and building and repairing dams. January 10 to February 13, 1891, the United States snag boat *Meigs* was employed in the river below Faisonia, but was withdrawn the latter date on account of high water. In addition to the removal of obstructions, brush dams were built by the *Meigs* at head of Muscle Shoals and at Hollywood Bar. The water remained too high to resume work until the latter part of May, but June 1, 1891, the snag boat *Florence* was sent into this river and worked until the end of the month removing obstructions between the mouth and a point 18 miles above Faisonia. August 18–30, 1891, the small balance available was expended by the snag boat *Florence* in removing obstructions between the mouth and Faisonia.

Operations from 1879 to the close of the fiscal year 1892 extended over the navigable part of the river, from Clarksdale to the mouth, though little has been done above Faisonia since 1882 for the reason that it would have resulted in no benefit to commerce or navigation to clear the upper river and allow the lower part to remain obstructed, the appropriation being too small to permit work over the whole. To obtain the greatest benefit with the means available it has been the endeavor to keep the lower river open the year round with the view to extending navigation to Lehrton, or higher, as the work progresses. Regarding the benefits derived from the work done the steamboat men report as follows: Before the improvement commenced the river was navigable for very light boats about 6 months of the year; now it is navigable the year round but difficult and dangerous at low stages on account of shoals, snags, and sunken logs. Larger boats are used and make the round trip (about 180 miles and return) in five days, while before the improvement it was unusual for a boat to make the trip under eight days. Freight rates are reported to be 50 per cent less. The lands along the river are being cleared and settled rapidly of late years, which is attributed in part to the improved navigation.

In the fiscal year ending June 30, 1893, operations were continued as follows:

As the appropriation was too small to permit the purchase or construction of a boat for this work, and as a steamboat could not be hired at a reasonable rate, operations had to be deferred until one of the snag boats of the district could be spared from service in the stream to which it belongs. The United States snag boat *John R. Meigs*, P. R. Starr, master, commenced work at the mouth of the river January 31, 1893, and was employed between the mouth and Faisonia until March 25, and then withdrawn. A rise in the river the latter part of February prevented much work in the channel, but on reaching Faisonia February 24 the fall had set in, and the boat turned back to work over the stretch above Woodburn. A chopping party was employed along the banks to remove stumps, shore snags and leaning trees in connection with the removal of obstructions in the channel by the *Meigs*. Many snags that could not be got at on the first trip were removed easily with the drag chain. At the wreck of the steamboat *Sarah E. Elliott* (sunk 1890), 1½ miles below Faisonia, the deck, deck beams, starboard side of the vessel, hog chain braces, wheel, shaft, and cylinder timbers were removed. By that time, March 18, the water had fallen so much that the snag boat could go only a short distance above the wreck, and after work of the shore party had been carried up to Faisonia the boat moved down to Vick Landing, the river being so narrow that it had to back its way to Porter Bayou before it could turn around. From Vick Landing the boat worked back upstream to the Georgia Pacific Railroad Bridge, removing between 50 and 60 dangerous snags from that stretch of river. I met the *Meigs* at the railway bridge the afternoon of March 22, and made an inspection of the Big

Sunflower River below that point and of Lower Yazoo River, arriving at Vicksburg March 25.

The following are the principal places where work was done by the *Meigs:* Red Rock Bend, Buck Point, Cypress Bend, Choctaw and above and below, Mud Lake, Deer Island, Hog Bayou, Muscle Shoals, Devil's Elbow, Dowling Bayou, Wildcat Bayou, Chicosa Point and Bend, Georgia Pacific Bridge, Indian Bayou, Rainy Day, Potato Hill, Stumpy Bend, Porter Bayou, Pulltight, Peter Manton's, above and below Vick Landing, Johnsonville, and Dead Man's Bend.

The following is a summary of the work done, viz:

| | |
|---|---|
| Snags pulled | 476 |
| Stumps pulled | 95 |
| Logs removed from channel | 547 |
| Side jams removed | 8 |
| Shore snags cut | 939 |
| Stumps cut | 2,859 |
| Leaning trees cut | 12,199 |
| Leaning trees topped | 162 |
| Trees girdled | 1,057 |
| Square yards brush and willows cut | 1,065 |

Wrecks removed, viz: Part steamer *Sarah E. Elliott,* below Faisonia.

The following extract from my annual report of 1891 remains applicable to this work:

> It is recommended that future appropriations shall not restrict expenditures to designated stretches of river, in order that the funds may be applied where the work is needed most and where it will yield the greatest benefit to navigation.
>
> The estimate of $66,000, made in 1879, for the improvement of this river (p. 984, Report Chief of Engineers, 1879) did not contemplate doing the work at irregular intervals extending over a period of fifteen years, as it will with the usual appropriations, but was made with a view to finishing it in not more than three or four consecutive seasons. As new obstructions are added from time to time it is impossible to make any definite estimate, but if an appropriation of not less than $20,000 is made it can be spent to advantage and with economy in one or two low-water seasons, and result in greater benefit to navigation and work of a more lasting character than a larger sum by small allotments every other year.

## *Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $64.89 |
| Amount appropriated by act approved July 13, 1892 | 5,000.00 |
| | 5,064.89 |
| June 30, 1893, amount expended during fiscal year | 4,367.80 |
| July 1, 1893, balance unexpended | 697.09 |
| July 1, 1893, outstanding liabilities | 24.05 |
| July 1, 1893, balance available | 673.04 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893. | 20,000.00 |

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### COMMERCIAL STATISTICS.

The river was navigable the entire year to Woodburn, 80 miles above the mouth; for four months to Faisonia, 144 miles above the mouth; and to Burch Place for about three months.

*List of steamboats that navigated Big Sunflower River in fiscal year 1893.*

| Name. | Class. | Tonnage. | Length. | Breadth. | Depth. | Draft. | | Between. | Round trips. | Passengers. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Light. | Loaded. | | | |
| | | | *Feet.* | *Feet.* | *Feet.* | *Ft. in.* | *Ft. in.* | | | |
| Birdie Bailey | Stern-wheel. | 109.74 | 111.0 | 22.0 | 3.5 | 1 10 | 4 0 | Vicksburg and Holly Bluff. | 21 | 150 |
| John F. Allen | ...do | 133.90 | 130.2 | 24.0 | 4.2 | 1 8 | 4 0 | ...do | 30 | 200 |
| Addie E. Faison | ...do | 241.50 | 135.0 | 30.6 | 4.9 | 2 2 | 5 0 | Vicksburg and Woodburn.<br>Vicksburg and Faisonia.<br>Vicksburg and Burch Place. | 5<br>2<br>2 | 60 |
| Des Arc | ...do | 40.88 | 95.0 | 18.0 | 3.0 | 1 4 | 3 0 | Vicksburg and Faisonia.<br>Vicksburg and the Nation. | 6<br>1 | 112 |
| Dyersburg* | ...do | 73.08 | 93.0 | 18.0 | 3.0 | 1 6 | 3 6 | Vicksburg and Woodburn.<br>Vicksburg and Lehrton. | 36<br>6 | 309 |
| Lancaster* | ...do | 156.09 | 135.6 | 23.5 | 3.8 | 1 10 | 3 6 | Vicksburg and Faisonia. | 1 | ...... |
| Uncle Billie*† | ...do | 79.81 | 88.0 | 17.7 | 3.9 | 1 4 | 3 0 | East Renova and Hushpuckana. | .... | ...... |
| Ferd. R. | ...do | ...... | ...... | ...... | ...... | 1 0 | 3 0 | Yazoo City and Campbellsville. | 2 | ...... |
| Joe Seay* | Tug | 27.74 | 75.0 | 16.0 | 6.0 | 7 0 | 8 0 | Vicksburg and 118 miles above mouth. | 1 | ...... |
| White Oak* | ...do | 31.32 | 69.0 | 13.0 | 6.4 | ...... | ...... | Not reported | .... | ...... |

*With barges. †Rafting.

*Summary of commerce reported.*

| Articles. | 1892-'93. | 1891-'92. | 1890-'91. | 1889-'90. | 1888-'89. |
|---|---|---|---|---|---|
| | *Tons.* | *Tons.* | *Tons.* | *Tons.* | *Tons.* |
| Cotton | 2,699 | 4,118 | 2,375 | 2,594 | 4,000 |
| Cotton seed | 5,250 | 5,450 | 3,500 | 3,975 | 6,000 |
| Hides | 19 | 12 | ............ | ............ | 1 |
| Live stock | 250 | 265 | 70 | 150 | 150 |
| Saw logs | 19,000 | 21,835 | 15,400 | 4,000 | ............ |
| Lumber | 1,130 | 906 | 920 | 869 | ............ |
| Staves | 9,840 | 4,430 | 3,219 | 5,250 | 490 |
| Miscellaneous | 1,088 | 2,549 | 2,027 | ............ | 3,880 |
| Total down freight | 39,276 | 39,565 | 27,511 | 16,838 | 14,521 |
| Return freight | 4,023 | 7,489 | 4,473 | 5,322 | 9,680 |
| Total | 43,299 | 47,054 | 31,984 | 22,160 | 24,201 |
| Estimated value | $893,000 | $1,354,000 | $945,000 | $1,240,000 | $1,858,000 |

The Yazoo and Mississippi Valley Railroad crosses the river at Clarksdale, and thence south runs parallel to the stream at distances varying from 5 to 20 miles. The Georgia Pacific Division of the Richmond and Danville Railroad crosses the river at Baird with a line running from Arkansas City on the Mississippi River to Atlanta, Ga.

## V 15.

## IMPROVEMENT OF BIG HATCHEE RIVER, TENNESSEE.

Big Hatchee River has its source in northern Mississippi, flows in a northwesterly and then westerly direction through the most productive region of West Tennessee, and enters Mississippi River 50 miles above Memphis. Navigation of this stream was commenced as early as 1827; in 1841 and 1842 the State of Tennessee appropriated $100,000 for improvement of rivers in the western part of the State, one-third of which was expended on Big Hatchee, after which considerable commerce developed, six or seven steamboats having been employed during the cotton season, and it is stated that there was navigation for light-draft boats the year round. In 1866 the legislature of Tennessee declared the stream unnavigable and authorized the construction of fixed railway bridges across it, in consequence of which navigation was suspended until 1879, when the act was repealed and the railroad companies changed their bridges to conform to the law.

Under section 2 of river and harbor act of August 14, 1876, which provided for "examination and survey of such rivers and harbors as, in the judgment of the Secretary of War, will subserve the general interests of commerce," an examination of this river was ordered, but, in view of the State law declaring the river unnavigable, it was deferred until after repeal of the act in 1879. The project, based upon this examination, contemplated the removal of snags, logs, leaning timber, etc., to render the stream navigable for light-draft boats throughout the year, from Bolivar, Tenn., to the mouth, a distance estimated to be about 240 miles. The plan contemplated completing work in three consecutive seasons of low water at a cost of $30,000. (Report Chief of Engineers, 1880, pp. 1330-1332.)

The appropriations are as follows:

| By act of— | |
|---|---|
| June 14, 1880 | $10,000 |
| March 3, 1881 | 3,500 |
| August 2, 1882 | 3,000 |
| July 5, 1884 | 2,500 |
| August 5, 1886 | 3,000 |
| August 11, 1888 | $5,000 |
| September 19, 1890 | 5,000 |
| July 13, 1892 | 3,500 |
| Total | 35,500 |

Operations from the commencement of the improvement by the United States to the close of the fiscal year 1892 were as follows:

A chopping party commenced work at Bolivar August 13, 1880, and continued downstream to the mouth of the river, which was reached December 10, 1880. This work consisted chiefly of clearing the leaning timber, but snags and logs were removed from the channel wherever practicable with the means at hand. In 1881 a chopping party resumed work at Bolivar June 22, and between that date and October 15 carried it down to the mouth, giving special attention to the removal of obstructions in the channel.

August 28 to November 4, 1882, the work was gone over again from Bolivar to Reed Landing, 27½ miles above the mouth, many new obstructions having been added during the year by caving banks, etc. Owing to lack of funds nothing further was done until December 14, 1884, when a chopping party commenced work at Piljerk Landing, 40 miles above the mouth, and continued upstream about 40 miles, thoroughly removing all obstructions to navigation until February 10, 1885, when operations were suspended by high water. Nothing was done the following low-water season, as the balance available was insufficient to resume operations. October 15, 1886, work was begun at the mouth and continued until January 15, 1887, when it was stopped by high water, having been carried up to Rialto, about 60 miles. The small balance was expended June 17–27, 1887, in working from Rialto back to the mouth, giving a fair navigable channel in that stretch of river. The next work, April 5 to June 14, 1889, was carried from Rialto upstream to the Louisville and Nashville Railroad Bridge, a distance of about 60 miles, and August 19 to October 31, 1889, a hand-propelled snag boat was employed in removing obstructions from the bottom of the river below Rialto, clearing a good channel between that place and the mouth, with a depth of 2½ feet at low stages. The next work was done by the United States snag boat *Florence*, January 1 to March 5, 1892, between the mouth and Green Landing, about 67 miles above, and was suspended by high water.

Before the improvement commenced the river virtually was unnavigable by reason of the obstructions; in 1889 it was reported navigable for seven months, and during the fiscal year 1891 it was reported navigable for nine months. Between Bolivar and its mouth the stream is crossed by four railroads about 60 miles apart, which transports the principal products of the adjacent country, and the main effect of the work done has been to facilitate the transportation of timber and staves and prevent excessive rates of freight. The fixed bridge of the Tennessee Midland Railway, about 60 miles below Bolivar, prevents navigation by steamers above that point. If that bridge were provided with a draw, and the snags and leaning timber removed so as to permit light-draft boats to run the year round, there is a possibility that steamboat trade might revive, though not to the extent of the period before the railroads were built.

No work was done during the fiscal year ending June 30, 1893. Owing to the difficulty of hiring a boat with sufficient power for the removal of obstructions at a reasonable cost, operations were deferred until the snag boat *Florence* can be spared for the service.

The small amount of commerce to be benefited is not at all commensurate to the cost of continuing this improvement, or to maintaining what has been done, and for this reason it is not believed that an additional appropriation can be expended profitably, unless a greatly increased business be developed.

*Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $2, 178.48 |
| Amount appropriated by act approved July 13, 1892 | 3, 500.00 |
| | 5, 678.48 |
| July 1, 1893, balance unexpended | 5, 678.48 |
| July 1, 1893, outstanding liabilities | 2.56 |
| July 1, 1893, balance available | 5, 675.92 |

COMMERCIAL STATISTICS.

This river was reported navigable for light-draft boats from November 1, 1892, to close of fiscal year.

*List of steamboats engaged in navigating Big Hatchee River in fiscal year 1893.*

| Name. | Class. | Tonnage. | Length. | Breadth. | Depth. | Draft. |  | Between— | Round trips. |
|---|---|---|---|---|---|---|---|---|---|
|  |  |  |  |  |  | Light. | Loaded. |  |  |
|  |  |  | *Feet.* | *Feet.* | *Feet.* | *Ft. In.* | *Ft. In.* |  |  |
| Joy Patton | Stern wheel. | 63.04 | 100.0 | 21.3 | 5.6 |  |  | Not reported |  |
| Atlanta | do | 85.03 | 93.0 | 16.4 | 3.7 |  |  | do |  |
| White Oak | Tug | 31.32 | 69.0 | 13.0 | 6.4 | 5 6 | 8 6 | Eastanoula and mouth.<br>Green Landing and mouth. | 1<br>1 |
| Thomas Heidel | do | 10.09 | 51.0 | 10.0 | 3.8 |  |  | Cincinnati, Ohio, and Big Hatchee River. | 1 |
| Turtle | do | 5.00 | 30.0 | 8.0 | 2.0 |  |  | Not reported |  |

*Summary of commerce reported.*

| Articles. | 1892-'93. | 1891-'92. | 1890-'91. |
|---|---|---|---|
|  | *Tons.* | *Tons.* | *Tons.* |
| Cotton |  |  | 23 |
| Lumber (saw logs) |  | 4,450 | 6,010 |
| Staves and heading | 5,079 | 500 | 11,600 |
| Miscellaneous |  |  | 25 |
| Total | 5,079 | 4,950 | 17,658 |
| Estimated value | $34,500 | $30,000 | $184,500 |

The Illinois Central Railroad crosses the river at Bolivar, the head of proposed improvement; the Tennessee Midland Railway crosses at Hatchie Station, about 178 miles above the mouth; the Louisville and Nashville Railroad crosses at Big Hatchie Station, about 117 miles above the mouth; and the Newport News and Mississippi Valley Railroad crosses at Rialto, about 57 miles above the mouth.

## V 16.

## IMPROVEMENT OF FORKED DEER RIVER, TENNESSEE.

Main Forked Deer River, 24 miles long, is formed by the junction of the North and South forks in Dyer County, West Tennessee, about 9 miles below the town of Dyersburg, flows in a southwesterly direction, enters Obion River 4 miles above its mouth, and thus finds an outlet to the Mississippi at Hale Point, 95 miles above Memphis. Originally the mouth of Forked Deer River was near Ashport, 18 miles below Hale Point, but about fifty-four years ago the State of Tennessee cut a canal to a bend of the Mississippi (now the mouth of Obion River), shortening the length of main Forked Deer River about one-half. The original outlet below the canal is closed with snags and drift, and is called "old" and "lost" channels. The canal is known as "Tigertail." North Fork is formed by several small creeks near Trenton, in Gibson County, flows in a westerly direction to Dyersburg, thence southwesterly. South Fork heads in McNairy and Henderson counties, and flows in a general northwesterly direction. Appropriations aggregating $43,000 were made by the State of Tennessee for the improvement of Forked Deer River, at various times within the twenty years preceding 1874, but their expenditure resulted in little or no benefit to navigation.

Under river and harbor act of March 3, 1873, an examination was made from Dyersburg on the North Fork to mouth of main river, the report on which recommended that, in view of the cost of the work in comparison with the small amount of commerce to be benefited, the improvement should not be undertaken by the United States. (Report Chief of Engineers, 1874, Part I, pp. 372–380.) Under act of June 14, 1880, an examination of the South Fork and reëxamination of the North Fork and main river were made (Report Chief of Engineers, 1881, pp. 1489–1497), and under act of August 5, 1886, a third examination of North Fork below Dyersburg and the main river was made. (Report Chief of Engineers, 1887, pp. 1494, 1495.)

The original project contemplated the removal of snags, logs, leaning timber, etc., to give greater ease and safety to navigation of South Fork between Brownsville Landing and its junction with North Fork, a distance estimated to be about 73 miles, which was modified in 1883 so as to extend operations up to Jackson, Tenn., the head of navigation, about 74 miles above Brownsville Landing. By act of 1888 North Fork and main river were added under the general title improving Forked Deer River, and the project contemplated the same class of work in the 9 miles of North Fork below Dyersburg and thence down the main stream to the mouth. The estimates of cost were $19,250 for South Fork, $4,500 for North Fork, and $7,000 for the main river, based on plans for completing work in one season.

The appropriations have been as follows:

| | |
|---|---|
| By act of— | |
| August 2, 1882, for South Fork | $3,000 |
| July 5, 1884, for South Fork | 2,000 |
| August 5, 1886, for South Fork | 5,000 |
| August 11, 1888: | |
| For South Fork | 2,500 |
| For North Fork | 4,500 |
| For main river | 2,500 |
| September 19, 1890, for North Fork and main river | 2,500 |
| July 13, 1892, for completing improvement | 3,000 |
| Total | 25,000 |

Operations from the beginning of the improvement by the United States to the close of the fiscal year 1892, were as follows:

Work, with a chopping party, commenced at the mouth of South Fork July 7, 1883, and continued until November 16, 1883. During this period the water was at a low stage, and the removal of leaning timber, logs, snags, etc., was carried upstream to Jackson. Under the act of 1884 work was resumed October 1, 1884, at Jackson and carried downstream about 54 miles to Bell Depot, and suspended December 17, 1884, the available funds being exhausted. Nothing further was done until October 27, 1886, when operations were begun at the mouth, and between that date and June 16, 1887, were carried upstream to within 4 miles of Bell Depot. No work was done the following season, no funds being available. The next and last work done in South Fork commenced early in December, 1888, near the brush dam below Bell Depot. By means of explosives a channel 100 feet wide was cleared through the dam, after which the removal of snags, logs, leaning timber, etc., was carried up to Jackson and back to the mouth, reaching the latter point March 9, 1889. April 1–17, 1889, the balance available was expended by a small hand-propelled snag boat in removing leaning timber and heavy channel obstructions which had collected in the 8 miles above the mouth.

Work in the North Fork below Dyersburg was commenced by a chopping party October 3, 1888, at the mouth, and the principal shore work was completed November 27, 1888. Channel work with a hand-propelled snag boat, fitted with light shears and steam power, commenced December 6, 1888, and continued when the stages of water would permit until May 31, 1889, resulting in a good channel with a least depth of 2½ feet at ordinary low stages. November 1–23, 1889, the work was gone over, and it was found that the channel had scoured considerably and was well defined, with caving banks at but few places. Wherever there were evidences of caving the banks were cleared for some distance back, and the snags and stumps that had scoured loose were removed.

Work in the main river was begun with the hand-propelled snag boat November 10, 1888, but after twelve days' work was suspended by high water, which prevented resuming operations until June 10, 1889. From that date until the end of July, 1889, with the exception of a week's suspension by a sudden rise, the snag boat and a chopping party were employed in removing the obstructions as thoroughly as practicable with the limited amount available. At extreme low water the following October a number of stumps obstructing the channel below White Oak Landing were removed. November 2 to December 30, 1891, the United States snag boat *Florence* worked over the main river and North Fork below Dyersburg at a low stage of water, and did effective work in the way of removing obstructions from the channel.

The amounts expended to June 30, 1892, were $12,500 for South Fork and $9,496.25 for North Fork and the main river. With these expenditures the two forks were put in fairly good navigable condition, and the removal of obstructions from the main river enabled small boats to navigate it with greater ease and safety for a period of about eight months during the fiscal year 1892. Navigation of South Fork is carried on by flatboats, loaded with staves and lumber, and rafts of saw logs. Before the improvement commenced about one boat in three was lost on account of the obstructions; now they make the trip in comparative safety and at less cost. The work in North Fork below Dyersburg enables boats to run at a stage 3 feet lower than formerly.

No work was done during the fiscal year ending June 30, 1893. It was impracticable to hire a boat with sufficient power to remove obstructions at a reasonable cost, and operations were deferred until the United States snag boat *Florence* could be spared for the service.

With the amount available the river from Dyersburg to the mouth will be worked over as soon as practicable, completing the project for this improvement. In view of the limited amount of commerce (present and prospective) to be benefited, it is not believed that any further appropriation can be expended profitably, and no estimate is made for continuing work.

*Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $3.75 |
| Amount appropriated by act approved July 13, 1892 | 3,000.00 |
| | 3,003.75 |
| June 30, 1893, amount expended during fiscal year | 3.75 |
| July 1, 1893, balance unexpended | 3,000.00 |
| July 1, 1893, outstanding liabilities | 1.20 |
| July 1, 1893, balance available | 2,998.80 |

### COMMERCIAL STATISTICS.

The main river and North Fork were reported navigable for light-draft boats from November 1, 1892, to June 30, 1893.

The following was the only steamboat reported to have been engaged in navigation during the fiscal year 1893:

| Name. | Class. | Tonnage. | Length. | Breadth. | Depth. | Draft. | | Between— | Round trips. | Passengers. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Light. | Loaded. | | | |
| | | | *Feet.* | *Feet.* | *Feet.* | *Ft. In.* | *Ft. In.* | | | |
| James Laughlin (with 3 barges). | Tug | 28.76 | 71.5 | 15.0 | 4.5 | 5 0 | 5 6 | Band Mill and Dyersburg, Tenn. | 75 | 88 |

*Summary of commerce reported.*

| Articles. | 1892–'93. | 1891–'92. | 1890–'91. |
|---|---|---|---|
| | *Tons.* | *Tons.* | *Tons.* |
| Cotton | .......... | 98½ | 6 |
| Cotton seed | .......... | 100 | 25 |
| Hides and skins | .......... | 2½ | .......... |
| Live stock | .......... | 18 | .......... |
| Lumber (principally saw logs) | 25,650 | 12,000 | 9,200 |
| Staves | 445 | 3,580 | 24,000 |
| Miscellaneous | 276 | 44 | .......... |
| Total | 26,371 | 15,843 | 33,231 |
| Estimated value | $130,000 | $108,000 | $250,000 |

South Fork is crossed at Jackson by the Illinois Central Railroad, the Mobile and Ohio Railroad, and the Tennessee Midland Railway, and at Bells Depot by the Louisville and Nashville Railroad; and the Newport News and Mississippi Valley Railroad crosses North Fork at Dyersburg.

## V 17.

## WATER GAUGES ON MISSISSIPPI RIVER AND ITS PRINCIPAL TRIBUTARIES.

These gauges were designed to secure information from continuous records, with a view to protection of the alluvial lands against overflow, the improvement of navigation, and to give correct reports of the stages of water for the benefit of river men and planters. They were ordered by joint resolution of Congress approved February 21, 1871 (section 5252, Revised Statutes), viz:

SEC. 5252. The Secretary of War is hereby authorized and directed to have water gauges established and daily observations made of the rise and fall of the Lower Mississippi River and its chief tributaries at or in the vicinity of St. Louis, Cairo, Memphis, Helena, Napoleon, Providence, Vicksburg, Red River Landing, Baton Rouge, and Carrollton, on the Mississippi, between the mouth of the Missouri and the Gulf of Mexico; and at or in the vicinity of Fort Leavenworth, on the Missouri; Rock Island, on the Upper Mississippi; Louisville, on the Ohio; Florence, on the Tennessee; Jacksonport, on the White River; Little Rock, on the Arkansas, and Alexandria, on the Red River, and at such other places as the Secretary of War may deem advisable. The expenditure for the same shall be made from the appropriation for the improvement of rivers and harbors, but the annual cost of the observations shall not exceed the sum of $5,000.

All of the gauges directed by the foregoing resolution were established the latter part of 1871, except the one at Carrollton, La., established in January, 1872. A gauge was placed at the mouth of White River instead of at Napoleon, Ark., as the latter place was caving fast into the river. Two gauges were established at Louisville, Ky., one being needed at the head and one at the foot of the falls, and at the request of the steamboat men a gauge was set up at Natchez, Miss.

A gauge was established at Nashville, Tenn., on Cumberland River, in August, 1873. Additional gauges were established on Red River at Shreveport, La., Garland, Ark., and Fulton, Ark., in February, 1890, and one at Donaldsonville, La., on the Mississippi, in June, 1890.

The gauge at Rock Island, Ill., was discontinued April 30, 1879, because observations so far upstream were needed no longer, and the gauge at Fort Leavenworth, Kans., was abandoned November 30, 1886, but readings at the latter place have been continued by the Missouri River Commission.

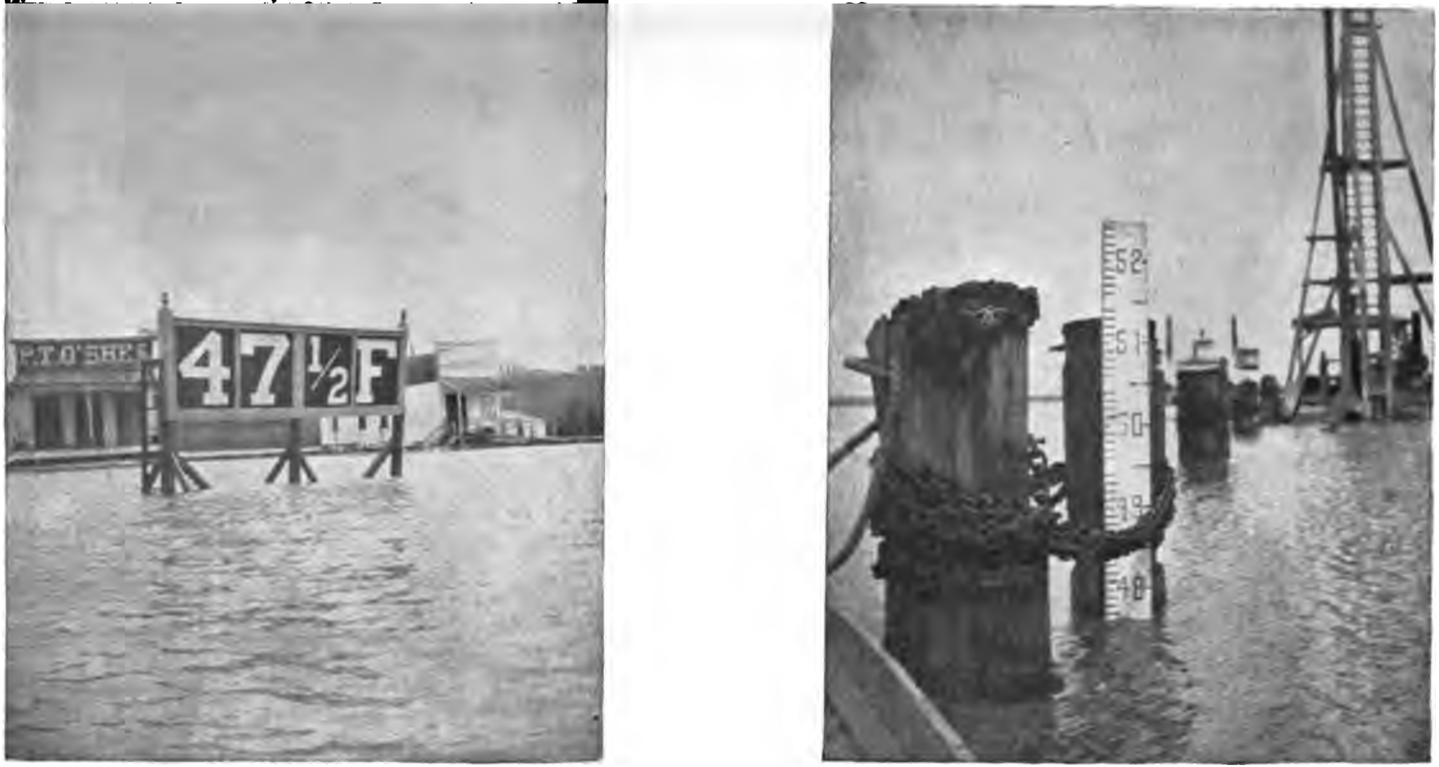
In 1881 bulletins were erected at the stations on the Mississippi for the purpose of giving passing steamboats the stage of water at each reading of the gauge, and showing whether the river was rising, stationary, or falling. The size of the plates in the original bulletins was 20¾ by 24 inches, black figures on white ground, but in 1890 they were replaced by larger bulletins, one-sixteenth inch sheet-iron plates, each 40 by 48 inches, white figures on black ground, which are large enough to be read easily with the naked eye at a distance of half a mile. The old bulletins were repaired and used in extending the service to the tributaries.

The gauge staves are now made in advance at the office and shipped when needed, a few sections being kept on hand at stations with caving banks or where the gauge must be set in an exposed place. They are of two forms, the larger to be bolted to bridges, wharves, and the like, and the smaller for temporary service, to be driven into the bank at successive stages, rising or falling. Numbers and graduations, feet and tenths are branded, thus saving time and money and giving uniform scales. The accompanying print is from a No. 4 Kodak negative, and shows the bulletin and vertical gauge at Vicksburg (Kleinston) just after high water.

From 1871 to February 1, 1887, the gauges were read and bulletins changed at 8 a. m. daily, but since the latter date this has been done at 8 a. m. and 4 p. m. every day, in order to obtain greater uniformity and accuracy.

The engineer gauges are used by the Weather Bureau at St. Louis, Mo., Cairo, Ill., Memphis, Tenn,, Helena, Ark., Vicksburg, Miss., Nashville Tenn., Alexandria, La., Shreveport, La., and Fulton, Ark.

During the fiscal year ending June 30, 1893, observations were continued at the twenty-two gauges, located as follows: On Mississippi River at St. Louis Mo., Cairo, Ill., Memphis, Tenn., Helena, Ark., mouth of White River, Arkansas, Lake Providence, Louisiana, Vicksburg, Miss., Natchez, Miss., Red River Landing, Louisiana, Baton Rouge, La., Donaldsonville, La., and Carrollton (New Orleans), La.; on Ohio River at Louisville, Ky., head of falls and foot of falls; on Tennessee River at Florence, Ala.; on Cumberland River at Nashville, Tenn.; on White River at Jacksonport, Ark.; on Arkansas River at Little Rock, Ark.; and on Red River at Alexandria and Shreveport, La., and Garland and Fulton, Ark. The gauge readings are received at this office weekly, reviewed, consolidated, and sent to the secretary of the Mississippi River Commission, by whom they have been published to the end of the calendar year 1892.



Bulletin.

Gauge.

U. S. WATER-GAUGE STATION AT KLEINSTON, MISS.

Records of the daily readings were furnished the president of the Mississippi River Commission; copy of the Florence Record was furnished the engineer officer in charge of Lower Tennessee River; copy of the Carrollton record was sent the assistant engineer at South Pass of the Mississippi; and copies of the records at various stations were furnished district officers and levee commissioners during the flood season.

The following gauges were inspected by Assistant Engineer John Ewens during the year, viz:

*September.*—(16th) Lake Providence, Louisiana, gauge rebuilt from —3 to 37.1-foot mark; (20th) Natchez, Miss., gauge rebuilt from —1 to 50 footmark; (21st) Red River Landing, Louisiana, gauge rebuilt from 0 to 43 footmark; (27th) Vicksburg, Miss., gauge rebuilt from —1.3 to 52.3. footmark.

*October.*—(5th) Memphis, Tenn., gauge rebuilt from —3 to 14.6 footmark; (12th) Little Rock, Ark., gauge rebuilt from 0 to 11 footmark; (21st) Shreveport, La.; (24th) Alexandria, La., gauge rebuilt from 23.5 to 39 footmark.

*November.*—(4th) Natchez, Miss.

*December.*—(9th) Garland, Ark.; (10th) Fulton, Ark.; (13th) Little Rock, Ark.; (14th) Jacksonport, Ark., gauge rebuilt from 6 to 36.4 footmark; (15th) Memphis, Tenn.; (16th) Helena, Ark.

*March.*—(15th) Vicksburg, Miss., gauge rebuilt from 32.5 to 51 footmark.

*April.*—(15th) Fulton, Ark.

*May.*—(2d) Baton Rouge, La., gauge rebuilt from 21 to 37 footmark and site of bulletin changed; (4th) Donaldsonville, La., gauge rebuilt from 0 to 30.9 footmark; (5th) Carrollton, La., gauge rebuilt from 0 to 19 footmark and bulletin moved from unsafe position near caving bank.

The following gauges were inspected by Assistant Engineer T. C. Thomas, of the Red River Survey, while en route to Vicksburg on the United States steamer *Florence*, viz:

*March.*—(16th) Red River Landing, La., gauge reset from 33 to 43 footmark; (17th) Natchez, Miss., gauge reset from 38 to 50 footmark.

The limited means available prevented the frequent and rigid inspections essential to accuracy of the readings and records, and for this reason the results of the year's work have not been as satisfactory as could be desired.

The service, begun in 1871, has been extended and improved until it has grown to be a large and important system of collecting valuable information for the improvement of many streams; for giving correct river reports to those interested in navigation; prompt warnings to those living in sections subject to overflow; information to the planting interests of the alluvial valley, and for distributing and preserving the records for future use. As the value of the observations and the practical use of the bulletins become appreciated, requests are made by river men for new gauges or for bulletins at important stations on the tributaries.

Gauge stations have been established on tributary streams in connection with their improvement, some of which might be transferred to this service with benefit to all concerned. There are several gauges in each district on Mississippi River between St. Louis and New Orleans, the reports of which are sent to the secretary of the Commission, but the records of all can not be equally valuable, as the gauges are not inspected regularly or uniformly. Rigid inspection is necessary to insure careful observations, to maintain the gauge zeros invariable, and to a well ordered and efficient service, which can be secured in no other way without great cost, and for this reason the recommendation of former reports, that the entire gauge service should be under one management, is repeated in the interest of economy and good service.

The present method of setting the gauges is not satisfactory. When the service was begun in 1871, the late Col. William E. Merrill, the officer charged with the duty, endeavored to set the gauges at the stations of the Delta Survey to read in harmony with the gauges of 1851–'58, and at the new stations to put the zeros at the lowest water known; but while his information may have been the best attainable it was by no means absolute, and in many instances the water has fallen considerably lower than indicated by the "oldest river man." The uncertainty about past low waters is noted in reports both at home and abroad, and is well stated in the report commonly known as "Humphreys and Abbot," or Professional Paper No. 13, Corps of Engineers, page 102, edition 1876, as follows:

> *Range of the Mississippi between low and high water.*
>
> It is very difficult to obtain exact verbal information upon this subject, because when the river has once retired within its banks it becomes harmless, and few persons care to record its changes until it again excites alarm by a new rise. Moreover, it seldom remains stationary for more than a day or two at a time, even at low water, and a series of measurements is therefore necessary to determine which, among many oscillations, includes the lowest point attained in any given year. Add to this the practical difficulty of ascertaining, by any instrument at the command of the unprofessional observer, an absolute difference of level which often amounts to over 40 feet, and no surprise will be felt that few data other than the measurements of this survey can be presented in reference to the range of the river.

To prevent errors in recording observations, the zeros of the gauges should be set so there shall be no negative readings, and therefore it has been proposed to put them at the lowest water known or recorded at each station. But since one of the results of improving rivers is to lower both high and low water limits, another change would be required after a few years. In "Stages of the Mississippi River and of its Principal Tributaries for the calendar year 1892," issued by the secretary of the Mississippi River Commission, there are twenty-five gauges that show negative readings for lowest water; for example: Lake Providence, −3.85; Vicksburg, −3.91; Bayou Sara, −2.10; Carrollton, −1.60; Shreveport, −2; Alexandria, −3.70; Yazoo City, −4.30; Wittsburg, −3.60. The gauge at Fulton on Red River was reset 3 feet below the Signal Service gauge, and low water has fallen to +0.60 and will certainly fall below zero within a few years. Since the removal of the great raft Red River has deepened greatly, and the low-water line has fallen more than 15 feet at the point known as "head of the raft," as shown by the levels of Red River survey. If, therefore, the zeros should be changed the reform should be radical, and all the zeros should be put at the same reference, say the Cairo datum of the Engineer Department and of the Commission; or, if preferred, at mean Gulf level. Thus: Vicksburg gauge, zero = 66.04 feet above Cairo datum; highest water May, 1862, = +51.10 = 117.14 Cairo datum; lowest water September, 1887, = — 3.90 = 62.14 Cairo datum; oscillation, 55 feet. Gauge curves may be plotted directly from observations by this method, and in testing from established bench marks the final height of instrument should be read on the gauge if not disturbed, or give the necessary correction, which could be made at once under the eye of the inspector. The weekly reports of gauges set in this manner also would attract attention more quickly in case of disturbance or false reading, and serve as an immediate check upon the observer without the necessity of reducing and plotting the observations, as is now required.

Search for benches and high-water elevations of the Delta Survey was continued whenever time could be spared for the purpose, and all of the level notes of 1851-'58 and 1859 extant were revised and checked. It is hoped that all available information on the subject may be put in tabulated form for the next annual report. Most of the original benches were standing when the gauges were reëstablished in 1871, and should have been connected then with those for the new gauges. It may be that the small amount of the appropriation prevented or that the importance of the subject was not realized; yet one day's work of the inspector at each station would have been sufficient, and the results could have been revised by the officers of the Delta Survey, most of whom were still in service. The following is given as a progress report:

The zero for the Cairo gauge in 1857 was taken at mean low water of the Cairo City Company, 43.54 feet below the iron water table of Stevens & Williams's store on the levee, now occupied by the Iron Mountain Railroad Company, and was 300. feet above the reference plane known as Cairo datum, or 9.16 feet above zero of present gauge. The levels of 1857 were in error 1.4 feet, and the "highest water known," 37.50 feet, was in fact the ordinary high water of the Cairo company. No gauge was put up, but the elevations were obtained by the level for each observation.

High water of 1858 at Columbus has been deduced in the office of the secretary of the Commission from the elevation of a mark in a house pointed out by the occupant as the high-water mark of that year. The elevations of benches and the gauge record in Appendix B of the Delta report do not agree with the level notes and original record, and require an adjustment.

The bench at Memphis is lost, but Major Benyaurd's coefficient for changing to present gauge is practically correct.

There is small hope of recovering the elevations at Napoleon and Lake Providence, except indirectly through the transalluvial levels to Yazoo and Ouachita rivers.

The benches on the Catholic church at Vicksburg have been found and referred to Cairo datum, making zero of 1858 1.32± feet below present zero. High water of 1862 was pointed out to me by Pilot Conklin, who read the description of the mark from a notebook before taking me to it. Its elevation was 117.14 feet above Cairo datum, or 51.10 feet on the present gauge, being the highest water known, though it may have been exceeded by that of 1828, when the Yazoo Valley remained flooded from February to August. The authority for this statement was Captain Auter, who followed the river at the time and who died recently at an advanced age. This agrees with notes found in the journal of the survey of 1851 about high water at Natchez, Red River Landing, and Baton Rouge, based on the statements of living witnesses.

The bench at Browns Mill, above Natchez, was standing in 1871, but as it was not connected with the new gauge or with the later gauge in 1874, and as the elevation in Appendix B does not agree with Lieut. G. K. Warren's report of 1851, it is doubtful if its elevation above Cairo datum can be determined. Two benches and high-water marks of 1858 at Vidalia, opposite Natchez, have been found and connected with the Coast Survey levels. The benches of 1851 at Plaquemine and Donaldsonville have been lost, but the high waters of early years may be approximated from the level notes and from plotted hydrographs, and a bench of 1858 still remains at Plaquemine, which has been connected with the Commission levels.

At Baton Rouge the bench originally established by Mr. Waller in March, 1851, has been identified with that of the State engineers, Coast Survey, and United States Engineers. It is 82.651 feet above Cairo datum, and the zero of the gauge of 1851 at McMain's sawmill, about a mile above Baton Rouge, was 21.339 feet Cairo datum. High water of 1851 on this gauge read 33.4± feet, or 54.739 feet Cairo datum, and an elevation of high water of that year, taken June 17, 1851, in front of the city near the site of the present gauge, confirmed by one on the opposite side, only 0.033 foot less, gave 54.627 feet Cairo datum, or a fall of 0.112 foot between gauges. The fall between high-water marks of 1849 for about the same distance was 0.124 foot. The zero of the present gauge is 1.279± feet lower than that of 1851, thus confirming the coefficient of +1.1 given by Major Benyaurd in 1876; but, since the level notes gave other values for early high-water marks than those published, the following table has been made for the present gauge:

| Year. | High water. | Low water. | Year. | High water. | Low water. |
|---|---|---|---|---|---|
| 1828 | 34.69+ | | 1854 | | 0.29 |
| 1844 | 33.41± | | 1858 | 34.84 | |
| 1849 | 34.40± | | 1862 | 36.09 | |
| 1850 | 33.90± | 2.65 | 1892 | 38.45 | 2.60 |
| 1851 | 34.57 | 3.57 | 1893 | 38.40 | |
| 1852 | 32.07 | 3.97 | | | |

The elevations of benches and gauge heights at Red River Landing (Torras) and Carrollton (Hampson) were derived from the level notes of 1851 to 1859, through the benches at Baton Rouge and Convent, the latter also having been found and connected with the Coast Survey bench in the convent grounds above College Point, with a discrepancy of only 0.355 foot. Between Baton Rouge and Red River Landing I found an arithmetical error of 1 foot in the west bank levels, and between Convent and Carrollton an evident error in the elevation of the first bench below Bonnet Carré of 0.798 foot, and an arithmetical error of 0.062 foot in closing the main line. Correcting only these errors, the final discrepancy in elevation of Hampson bench by the levels of 1851 and those of the Coast Survey of 1880 appears to be 0.103 foot. The gauges at both stations having been disturbed quite often, the high waters in the original records were tested by the level notes. The following table contains a number of high and low water elevations at Red River landing reduced to the present gauge, which are given as close approximations to the truth. The zero of the present gauge is 23.85 feet above Cairo datum.

*Red River Landing.*

| | High water. | Low water. | | High water. | Low water. |
|---|---|---|---|---|---|
| 1828, March to August | 48.39 | | 1867 | 46.33 | |
| 1844 | 46.00 | | 1871 | 44.50 | 2.05 |
| 1850, March | 44.93 | 0.00 | 1872, May 6 | 39.42 | Dec. 15, 0.00 |
| 1851, April 1 | 44.68 | Nov. 24, 0.79 | * * * * | * | * * |
| 1852, June 8 | 42.24 | | 1892, June 28 | 48.87 | Oct. 31, 2.12 |
| 1858, July 13 | 44.12 | Nov. 3, 4.44 | 1893, June 25–27 | 47.72 | |
| 1859, May | 44.54 | | | | |

The level notes of 1851 gave the zero of the Delta gauge at Carrollton 8.203 feet below "Hampson," instead of 7.92 as published, and 0.146 foot lower than the present gauge, which happens to be set as near as can be at the mean gulf level of the Coast Survey. The following heights reduced to the present gauge are believed to be correct within ±0.1:

*Carrollton, La.*

| | High water. | Low water. | | High water. | Low water. |
|---|---|---|---|---|---|
| 1849, March | 15.68 | | 1862 | 15.35+ | |
| 1851, March | 15.30 | Nov., 0.10 | * * * * | * | * * |
| 1858, May | 14.95 | Nov., 0.25 | 1892, June 10 | 17.35 | Nov., 0.20 |
| 1859, May | 15.40 | Nov., —0.60 | 1893, June 22 | 17.45 | |

As a final reform, the graduations should be in the metric system to insure more accurate observations. The bulletin service for pilots and general information could be posted by means of a duplicate gauge or from a reduction table in the observer's book, using the lowest or an adopted low water as standard.

Attention is invited to that portion of my report of 1891 regarding the decision, made in April, 1891, that section 6 of the river and harbor act of August 11, 1888, allows only $6,000 to be drawn during each fiscal year (pages 2016, 2017, Report Chief of Engineers, 1891), and also to the fact that during the two fiscal years preceding 1891 it was held that the amount available for each year was $9,600, and the recommendation is repeated that section 6 of the act of August 11, 1888, be amended to grant in unmistakable terms a permanent appropriation of such amount as may be necessary to do the work, not to exceed in the aggregate for each fiscal year the sum of $12,000, according to the following estimates, viz:

| | |
|---|---|
| Wages of observers | $5,000 |
| Repairs of gauges and bulletins | 800 |
| Pay and traveling expenses of inspector and wages of extra help at gauge stations | 2,700 |
| Permanent bench marks | 300 |
| Level connections | 2,000 |
| Record books, blanks, stationery, telegrams, etc | 200 |
| Office expenses | 500 |
| Mileage and transportation | 500 |
| Total | 12,000 |

This amount would provide for the maintenance and perfection of the present gauges; a judicious extension of the service by embracing all other gauges now on the Lower Mississippi and the principal ones on the tributaries, and establishing new ones at such places as may be deemed advisable; putting gauges on the Lower Mississippi and its chief tributaries under one management and one system of inspection, with greater economy and advantage to the entire service. Frequent inspections could be made to prevent errors in the gauges and records, and gradual level connections could be obtained with the Cairo datum, the common reference plane of the Engineer Department and the Mississippi River Commission, to give the greatest value to the records.

It is urged, also, that the gaugings at or near St. Paul, Minn., which under the act of August 11, 1888, are to be paid for out of the annual appropriation for gauging the waters of the Mississippi River and its tributaries, be provided for by a separate and distinct appropriation, as the gaugings are of a different kind, consisting of discharge measurements during the operation of the reservoirs at the head-waters of the Mississippi River, without connection with the gauges on the Lower Mississippi River and its tributaries. Being in charge of another officer, their cost is not included in my estimates.

*Comparison of flood of 1893 with highest water recorded since establishment of present gauges.*

| Gauge stations. | Year gauge was established | Elevation of gauge zero above Cairo datum plane. | Elevation of gauge zero above mean gulf level at Biloxi, Miss. (preliminary).* | Highest water previously recorded on present gauge. | | Highest water during fiscal year ending June 30, 1893. | | Relation to previous highest record. | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Date. | Gauge reading. | Date. | Gauge reading. | Above. | Below. |
| | | *Feet.* | *Feet.* | | *Feet.* | | *Feet.* | | |
| St. Louis, Mo | 1871 | 400.23 | 378.97 | May 19, 1892 | 35.95 | May 8 | 31.60 | ...... | 4.35 |
| Cairo, Ill | 1871 | 290.84 | 269.58 | Feb. 27, 1883 | 52.17 | May 9 | 49.33 | ...... | 2.84 |
| Memphis, Tenn | 1871 | 203.97 | 182.71 | Mar. 23, 24; Apr. 4, 5, '90 | 35.60 | May 15, 16 | 35.20 | ...... | .40 |
| Helena, Ark | 1871 | 161.98 | 140.72 | Apr. 30, 1886 | 48.10 | May 25 | 47.92 | ...... | .18 |
| Mouth White River, Arkansas. | 1871 | 128.73 | 107.47 | Mar. 31, 1890 | 50.40 | May 29 | 49.48 | ...... | .92 |
| Lake Providence, La | 1871 | 89.62 | 68.36 | June 2, 1892 | 41.90 | May 15-17 | 41.85 | ...... | .05 |
| Vicksburg, Miss | 1871 | 66.04 | 44.78 | Apr. 24, 25, '90 | 49.05 | May 22, 23 | 48.30 | ...... | .75 |
| Natchez, Miss | 1871 | 36.89 | 15.63 | Apr. 23, 1890 | 48.60 | July 1<br>Ju'e 20, 22 | 47.60<br>46.10 | ......<br>...... | 1.00<br>2.50 |
| Red River Landing, La | 1871 | 23.85 | 2.59 | June 27, 1892 | 48.87 | July 1<br>Ju'e 25-27 | 48.71<br>47.72 | ......<br>...... | .16<br>1.15 |
| Baton Rouge, La | 1871 | 20.06 | —1.20 | June 28, 1892 | 38.45 | June 23 | 38.40 | ...... | .05 |
| Donaldsonville, La | 1890 | †19.14 | †—2.12 | June 13, 1892 | 30.15 | June 23 | 30.60 | .45 | ..... |
| Carrollton, La | 1872 | 20.91 | —0.35 | June 10, 1892 | 17.35 | June 22 | 17.45 | .10 | ..... |
| Louisville, Ky. (upper) | 1871 | †419.76 | †398.50 | Feb. 16, 1884 | 46.60 | Feb. 21 | 28.80 | ...... | 17.80 |
| Louisville, Ky. (lower) | 1871 | †392.85 | †371.59 | ....do ....... | 72.00 | Feb. 22 | 54.40 | ...... | 17.60 |
| Florence, Ala | 1871 | ........ | .......... | Jan. 22, 1882 | 29.60 | Feb. 17 | 21.40 | ...... | 8.20 |
| Nashville, Tenn | 1873 | ........ | .......... | ....do ....... | 55.30 | Feb. 22 | 40.80 | ...... | 14.50 |
| Jacksonport, Ark | 1871 | ........ | .......... | Mar. 14, 1890 | 33.35 | May 3-5 | 31.15 | ...... | 2.20 |
| Little Rock, Ark | 1871 | 241.50 | 220.24 | May 21, 1892 | 31.20 | May 3 | 27.20 | ...... | 4.00 |
| Alexandria, La | 1871 | 64.46 | 43.20 | June 12, 13, '92 | 38.25 | July 1<br>Jan. 7 | 34.60<br>32.25 | ......<br>...... | 3.65<br>6.00 |
| Shreveport, La | 1890 | 161.27 | 140.01 | May 28, 1892 | 35.70 | Jan. 1, 2 | 29.10 | ...... | 6.60 |
| Garland, Ark | 1890 | 223.44 | 202.18 | May 24, 25, '92 | 28.40 | Dec. 18 | 27.25 | ...... | 1.15 |
| Fulton, Ark | 1890 | 244.78 | 223.52 | May 23, 24, '92 | 34.85 | Dec. 17, 18 | 30.25 | ...... | 4.60 |

* Mississippi River Commission preliminary value, 21.26 feet above Cairo datum plane.
† Preliminary value.

*Itemized statement of expenditures during the fiscal year ending June 30, 1893, submitted in compliance with requirements of section [illegible] of river and harbor act of 1888.*

| | | |
|---|---|---|
| **Observations:** | | |
| Pay of 21 permanent gauge-keepers from July 1, 1892, to June 30, 1893, inclusive | $3,660.00 | |
| | | $3,660.00 |
| **Inspections and repairs:** | | |
| Pay of assistant engineer, 6 $\frac{22}{30}$ months, at $150 | 1,010.00 | |
| Traveling expenses of assistant engineer while inspecting gauges | 129.50 | |
| Pay of employés hired to assist gauge inspector and to repair ganges and bulletins | 49.50 | |
| Material for repair of gauges | 181.45 | |
| Transportation of material for repair of gauges | 12.36 | |
| Mileage of officer in charge | 12.80 | |
| Pay of leveler, $\frac{7}{30}$ month, at $100 | 23.33 | |
| Traveling expenses of leveler | 6.25 | |
| | | 1,425.19 |

| | | |
|---|---|---|
| Office expenses and contingencies: | | |
| Pay of clerk, 1 $\frac{24}{30}$ months, at $75 | $135.00 | |
| Pay of copyist, 1 month, at $50 | 50.00 | |
| Stationery | 71.11 | |
| Photographic materials | 5,62 | |
| Proportion of expenses for precise leveling to gauges in connection with survey of Yazoo River | 151.25 | |
| | | $412.98 |
| Total | | 5,498.17 |

*Outstanding liabilities July 1, 1893.*

| | |
|---|---|
| Telegrams | $7.19 |
| Pay of deceased gauge-keeper, St. Louis, Mo., July 1-17, 1890 | 11.00 |
| Pay of deceased gauge-keeper, Garland, Ark., January 1-31, 1892 | 10.00 |
| Total | 28.19 |

### *Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $27.98 |
| Amount allotted for project for fiscal year ending June 30, 1893, approved July 15, 1892 | 5,500.00 |
| | 5,527.98 |
| June 30, 1893, amount expended during fiscal year | 5,498.17 |
| July 1, 1893, balance unexpended | 29.81 |
| July 1, 1893, outstanding liabilities | 28.19 |
| July 1, 1893, balance available | 1.62 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895 } Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893. | 12,000.00 |

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## V 18.

### SURVEY OF CYPRESS BAYOU AND THE LAKES BETWEEN JEFFERSON, TEX., AND SHREVEPORT, LA., TO ASCERTAIN IF NAVIGATION CAN BE MATERIALLY AND PERMANENTLY IMPROVED BY THE CONSTRUCTION OF LOCKS AND DAMS, AND THE PROBABLE COST THEREOF.

The report upon which the first appropriation for an extended survey of Cypress Bayou and the lakes was based was submitted February 26, 1890, pursuant to the following resolution:

[Fifty-first Congress, first session, Congress of the United States.]

IN THE HOUSE OF REPRESENTATIVES, *February 6, 1890.*

***Resolved***, That the Secretary of War is hereby requested to furnish to the House of Representatives, at as early a day as may be practicable, all information that may be obtained in his Department in relation to the improvement of Cypress Bayou and the lakes between Jefferson, Tex., and Shreveport, in the State of Louisiana, and that he make such suggestions as he may see proper for the improvement of such bayou and lakes and the amount necessary to accomplish the same.

Attest:

EDWD. MCPHERSON, *Clerk.*

The report contained an index of all former reports upon Cypress Bayou, the essential portions of previous examinations and projects for improving navigation between Jefferson and Shreveport, and statement of the work done under them. (Report Chief of Engineers, 1890, p. 1914.)

The survey was authorized by the following item in the river and harbor act of September 19, 1890, viz:

> The Secretary of War is hereby directed to cause a survey to be made of Cypress Bayou and the lakes between Jefferson, Tex., and Shreveport, La., in order to ascertain if the navigation of the said bayou and lakes can be materially and permanently improved by the construction of such dams, and locks and dams, as may be necessary, and, if found practicable, the probable cost thereof, and for this purpose the sum of ten thousand dollars, or so much thereof as may be necessary, is hereby appropriated.

Progress reports will be found in the Report of the Chief of Engineers for 1891, p. 2021, and 1892, p. 1668.

The fieldwork, including a resurvey of Cottonwood Bayou from Red River to Sodo Lake, levels, borings, and discharge observations, has been completed and the maps, profiles, and sections finished. The report of Assistant Engineer Marshall, who had charge of the survey in the field, is presented as a final report upon all details of the survey, with a plan for a navigable route to Jefferson by means of a dam, with wasteweir, across Sodo Lake, with entrance from Red River through Cottonwood Bayou by a lock with double gates.

This plan is a development of that recommended by Captain Howell (Report Chief of Engineers, 1874, p. 706), Cottonwood Bayou being substituted for the dredged cut across to Gold Point, with a lock in place of an open channel.

The survey has confirmed the truth of the statement in my last report (Report Chief of Engineers, 1892, p. 1670) that if the plan of 1874 had been carrid out "the water from Red River would not now reach the zero of the Jefferson gauge at low water," and proves that the final result would have been the same whether the dam had been built under the first project with "crest 14 feet below local high-water mark of 1866," under the second with "crest 2 feet above high water of 1866 on Red River," or under the third with a spill "9 feet below the high water of 1866" at the site of the dam. In other words, the dams would have caused greater or less overflow of the lake region in high water, but would have had no influence whatever upon extreme low water at Jefferson, except, perhaps, in delaying the date, depending upon the discharge section of the cut to Gold Point. Finally, presuming the cut to have been made stable, the current through it at certain differences of relative stage would have been too gréat for navigation into or from the lakes.

Cottonwood Bayou is the first natural entrance to Red River above Shreveport by which a navigable route could be made to the lakes, in connection with a dam across them, with any hope of success or expectation of moderate length of usefulness. But the objections to an open route through the bayou are greater than for that proposed to Gold Point, both because the fall from Red River to the lake is considerably more and because all of the outlets above Cottonwood Bayou through which the lake region was filled during the raft period have been closed or will be closed within the next two years in carrying on the work of improving Red River and completing the levee system from Blanton Bluff downstream. Cottonwood Bayou itself, perhaps, might be closed also if only the question of improving Red River should be considered, either permanently by embankment on the levee line or by a weir and sluices if it should be found advisable to convert the lakes into reservoirs. Assuming, however, that Cottonwood Bayou is to form part of the navigable route to Jefferson, the water supply of "Cypress Bayou and the lakes" will be limited to the natural drainage of their basin with that which may be let in from Red River through Cottonwood Bayou or through sluices near by. A lock will be required with double sets of gates, since the head may change from lake to river, according to the rise and fall. The site of the dam across Sodo Lake is somewhat below the lower mouth of Cottonwood Bayou, the waste-weir being put at reference 60 meters above Cairo datum and the embankment extended along the highest ground below Cottonwood Bayou to a point at the same elevation as the weir crest, the object being to avoid impounding too great an amount of water, which would increase the area of overflow so much as to endanger the levee system above and the lands for the protection of which they were built. The elevation of 60 meters for the weir crest is more than needed for the present or prospective commerce of Jefferson, the lowest water at that point being not less than 57, but seems to be required to reduce the fall from Red River through Cottonwood Bayou, which in extreme cases is now very near five meters.

To refer to earlier projects: The favorite plan for permanent "deep water from Jefferson to the Gulf," urged by people unacquainted with the facts about differences of level, slope, depth, and water supply, not only in the lakes but in Red River, was for a lock and dam at or above Albany Flats, with a channel dredged below, if necessary, either into Twelvemile Bayou or Cross Lake. The line to Cross Lake runs dry now, the low-water fall from the foot of Cottonwood Bayou to Shreveport being 8 meters; and it is beyond a doubt that if the dam were built there would be no water on its lower side in extreme low water and no navigable channel in Twelvemile Bayou to the lock, no matter how much dredging should be done between it and Shreveport, unless the cut were made at least 2 meters below lowest water known or expected at Shreveport to cause the bayou to fill by backwater; indeed, the cut would have to be much deeper than stated to allow for silting up, and it would be simply guesswork to estimate the life of the dredged channel. The lower miter sill of the lock would have to be set proportionally lower, and the lift would become so great as to require a second lock to enter the lake; or else a second lock and dam would have to be placed between that in the lake and Shreveport. In either case it is probable that a dredge would have to be kept on hand to maintain the channel below the locks, increasing the annual charge for operating and repairs, themselves by no means inconsiderable.

Finally, with this system the water supply would decrease with the improvement of Red River, the outlets on the right bank closing naturally even if the levee system were abandoned. The proofs of these assertions are found in observations along the river, and are established by the levels and soundings of various surveys since 1872, when the lake area was largest; benches having been found by which the elevations in the original notebooks have been reduced to the Cairo datum for comparison. The great increase in depth gained in Upper Red River since the raft was destroyed has been mentioned elsewhere, and is strikingly shown in the "Profiles and cross sections, Red River, near Cottonwood Bayou," mentioned in Assistant Engineer Marshall's report, and submitted herewith for publication, the comparison being made for about 32 kilometers of river (say 20 miles), beginning at the 155th mile below Fulton, Ark.

The progressive increase in channel depth is alone sufficient evidence of the work done by the increased discharge of Red River, which during the raft period was dissipated through the natural and artificial outlets on the right bank into the lakes. The channel bottom must continue to go down, carrying with it the high and low water limits, as the work of improving Red River goes on; and this will be more rapid with the extension of the levee system, in which so great progress has been made during the past fiscal year.

Under these conditions it is my opinion that it is not feasible to create and maintain slack-water navigation between Shreveport and Jefferson through Twelvemile Bayou or Cross Bayou and the lakes, by any system of locks and dams, except at a cost rising into millions.

For the route through Cottonwood Bayou, for which Assistant Engineer Marshall submits an estimate of $375,000, the following must be observed:

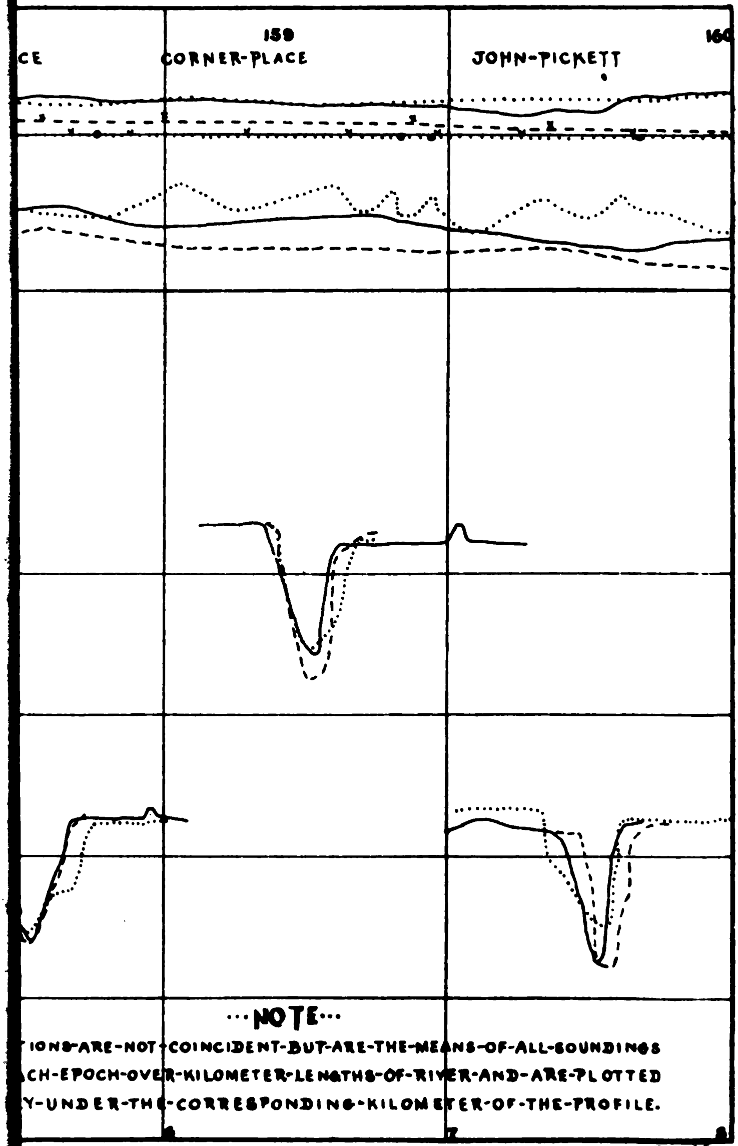
1. That all the outlets on the right bank which formerly supplied the lakes as far downstream as Cottonwood Bayou have been closed, or will be closed soon.

2. That the only argument for leaving Cottonwood Bayou open would be either with the hope of giving a permanent navigable route to Jefferson on the one hand, or, on the other, for the improvement of Red River by creating a reservoir in the present lake beds, to reduce flood heights in Red River from Cottonwood Bayou downstream, delivering the impounded water afterwards to improve the low-water navigation. This subject was touched on in my last report, as follows:

> As all of the water retained by the dam and levee would return to Red River when the latter should fall below the height corresponding to the crest of the dam, the route through Cottonwood Bayou should keep itself free, and should not be regarded as an injurious outlet, such as are those above which are to be closed, and therefore not opposed to the principles laid down for the improvement of Red River. Cottonwood Bayou would be closed as effectually by the dam and levee as by a dam across its mouth, and the plan of giving a navigable depth of 6 feet to Jefferson may be regarded as in effect the construction of a great reservoir to hold flood waters, somewhat after the plan of those advocated for the Upper Mississippi River. (Report Chief of Engineers, 1892, p. 1671, also 1880, p. 1281.)

When the preceding remarks were made the possible fall from Red River to the lakes through Cottonwood Bayou was not known. It has been measured on several occasions since by simultaneous observations, showing considerable variations, as was to have been expected; and on February 15, 1893, the water line from Jefferson to the lake end of Cottonwood Bayou and thence to Red River showed a depression corresponding to a fall of only 0.48 meter from Jefferson as compared with a fall of 4.16 meters from Red River, or nearly nine times greater fall through the bayou in a distance of 10 kilometers than that down the lake for a distance of 70 kilometers (say 13.65 feet in 6¼ miles to 1.57 feet in 44 miles), from which it may be seen that the bayou may be left open with safety to its banks and to navigation only when lake and river are near the same elevation; that is to say, locking would be required at all times when the difference of stage would create a current greater than about 2 miles per hour. The facts are illustrated on the profile and section of Cottonwood Bayou herewith.

3. The improvement desired being a permanent waterway from Jefferson to deep water sufficient for the present and all prospective needs of commerce, with the object of cheapening transportation rates, the junction with Red River will depend upon the navigable depth that can be maintained above Shreveport on the one hand, while on the other



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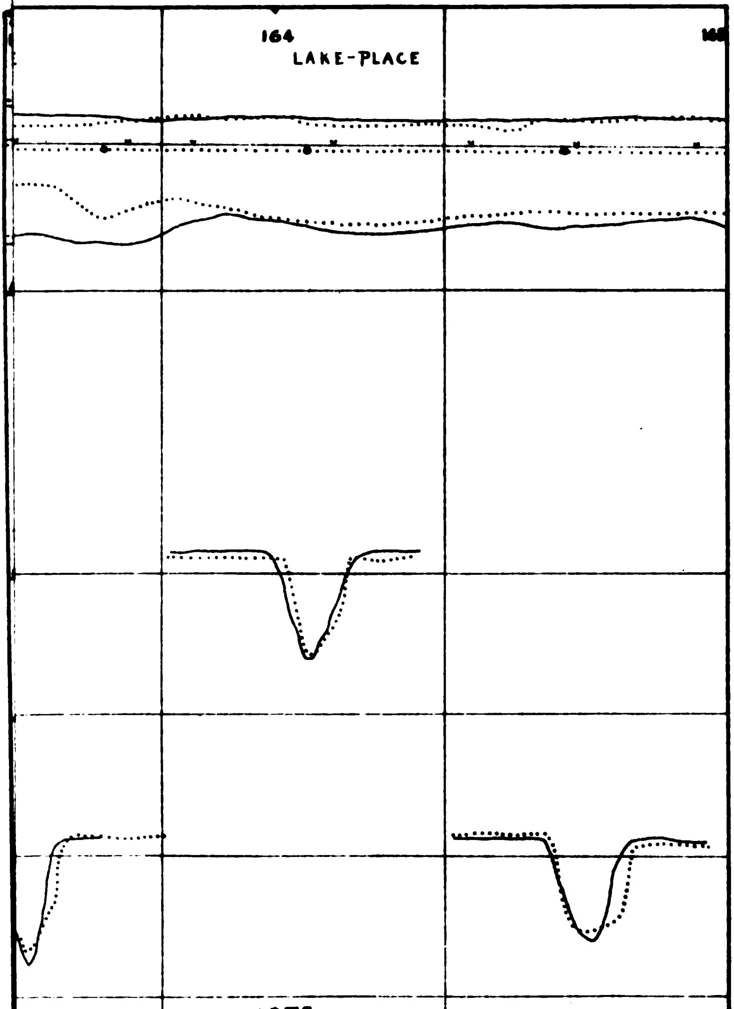

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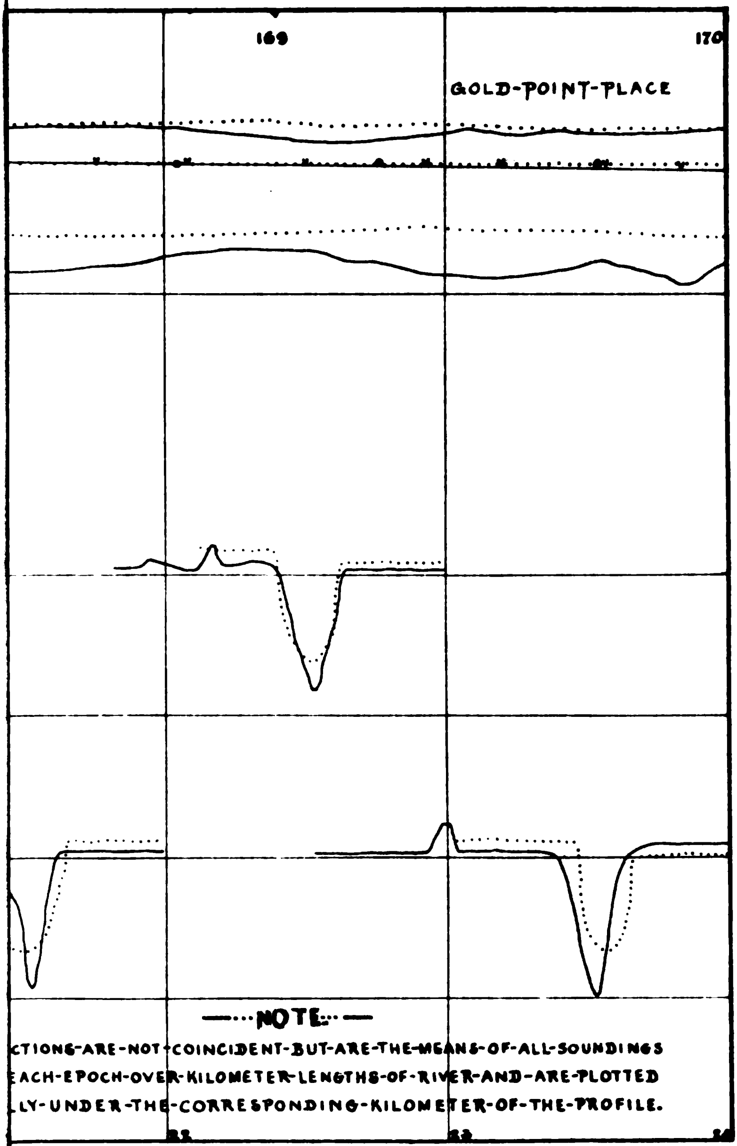

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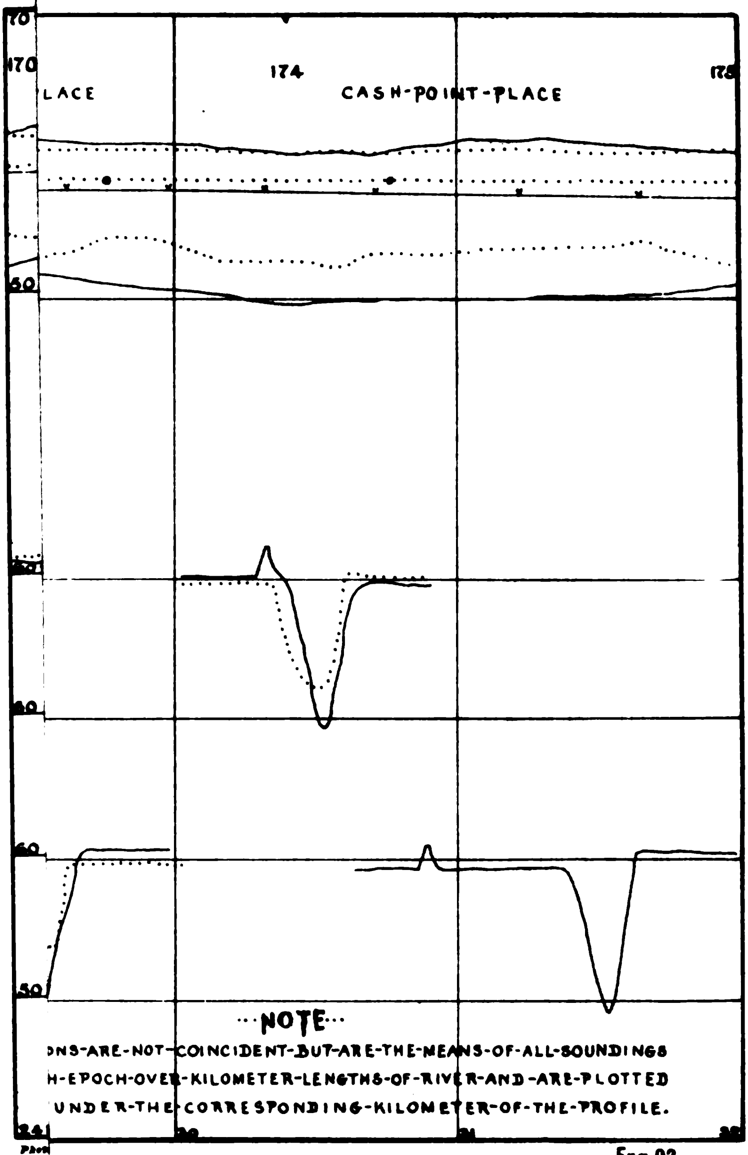
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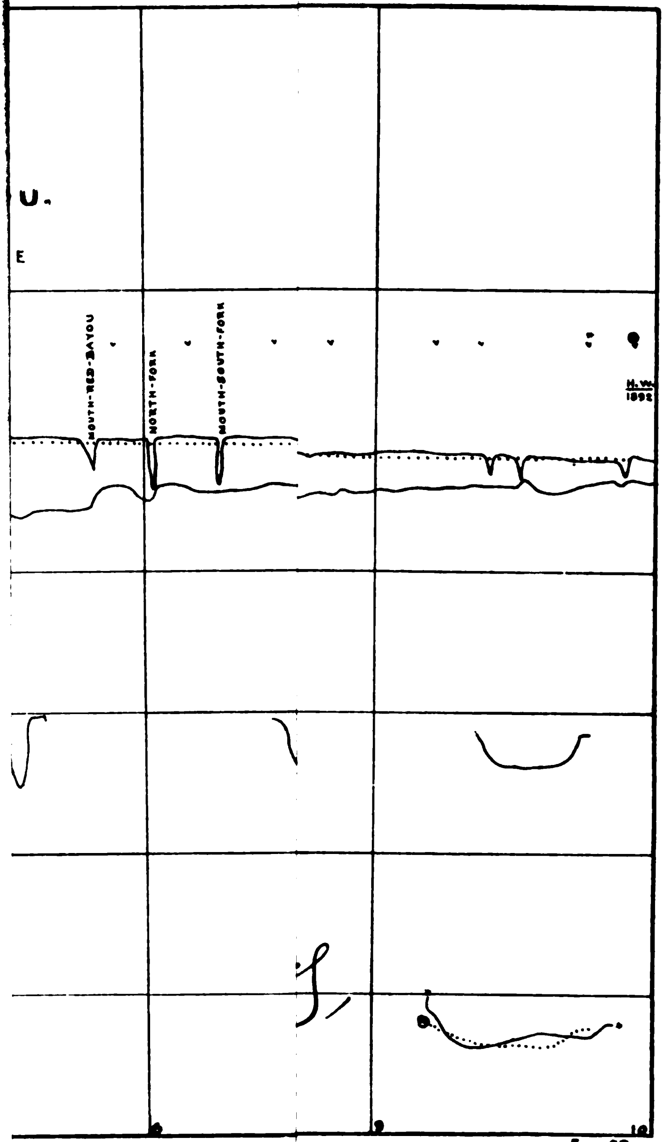

Eng 93

the distance from Shreveport to the entrance must be the least that will give the required depth in the lakes.

It is plain that for the inlet and outlet route the further upstream the entrance the greater the depth that might be had in the lakes by raising the dam; but this would not only increase the cost of construction, repairs, and operating, and flood a much larger area than needful, but add considerably to the expense of transportation, every mile upstream lengthening the route probably by more than twice that distance.

4. There are no special engineering difficulties in the way of building a dam and weir across the lake with spill of sufficient width to keep the lake within bounds without overtaxing the discharge capacity of Twelvemile Bayou. The borings show that the foundations will sustain any weight that may be put upon them, and there is plenty of room for a wide apron to prevent backlashing. There would be some difficulty in getting earth for the embankment up the bayou, and probably it would be best to strengthen this part of the line with sheet piling, especially as the riverward end will not connect with the levee system. The borings also disprove the notion that these lakes were formed by the same convulsion that made those at New Madrid, the strata plainly being water deposits without contortions that upheaval or sinking would produce, and the oak stumps as well as the cypress are everywhere found to be vertical. The explanation seems to be simple. The lands on the right bank were undulating, and Red River, like other alluvial streams, flowing down the easiest line, built up the banks until it was dammed by raft, when the water rose above them and cut through, filling the lowest parts as far as the Albany Hills, and then gradually washed down the barrier, which is now Albany Flats, until a stratum was reached hard enough to serve for a dam. After the raft was destroyed, and by repeated attacks of the snagboats, the channel marked out for Red River scoured out, its capacity increased till the greater part of the floods from above Blanton Bluffs was carried by the river, which formerly made the lakes, and as this process goes on the lake area must diminish till Albany Flats run dry at low water; and if they should be cut through, the State of Louisiana would become richer by some hundred thousand acres of fertile lands, free from overflow except by back water up Twelve mile Bayou.

5. The construction of a lock at the Red River end of Cottonwood Bayou would involve about the same risks and difficulties as those at New Orleans or Plaquemine, the question of special importance being the height for the miter sills.

It is under such conditions that the plan is submitted, with halfhearted recommendations and considerable misgivings, because the probable useful life of the improvement can not be estimated. The project is feasible and the estimate ample, it given in full. The height of the weir is only about 3 meters above low water in the lake, being in fact almost self-limited. The lock would be less expensive than usual with such constructions, notwithstanding the double sets of gates, since the masonry for the gates would not be continued to form the chamber. Double gates would be required, as stated, as the head may change from river to lake, with tops above highest flood limit. The bend at Cottonwood Bayou must be held and the banks secured above and below the entrance. The miter sill at the river end of the lock must be set as low as the depth in the bayou will permit to allow for fall in the low-water line in the river, which has been considerable since the removal of the raft. The process is still going on, but the rate is not known and the limit only a matter for conjecture. The high-water fall from Cottonwood Bayou to Shreveport in 1892 was 4.3 meters, and if the low-water fall should develop an average slope only twice as great the elevation of low water at the bayou corresponding to the lowest water recorded at Shreveport (—0.6 meter, 1892), would be about 57 meters Cairo datum, or more than two meters lower than recorded thus far, the fall now being 10.6 ± meters. The elevation to be given the miter sills is therefore the most difficult question to settle, and if the project should be adopted they must be put at a height just above possible deposit and the lock set at least far enough within the bayou for a second chamber with river miter sill proportionally lower. This will require the foundation courses of the first river bay to begin at an elevation below that estimated for a river miter sill to give a lift wall for the second lock. To make the route to Jefferson permanent might require a flight of locks or, if room were not allowed for them in the beginning, a lock and dam across Red River below the bayou, which beyond all doubt would be most disastrous to Red River. With more than one lock the idea of an open pass at certain stages would have to be abandoned. The abutments must be large enough for anchorage, two gate recesses, probably stop gates on either side the sills, and room for maneuvering. No special economy of water supply being necessary the sides of the chamber may be graded and paved and fender piles, with wearing pieces, put in to keep boats off the slopes. The masonry being above high-water limit will be connected by levees on each side back of the slopes, so that the lock may be operated during flood, and the levee should be extended back far enough to give room for lock-tenders' house, shops, etc. If the water supply should fail it may be necessary to build a sluiceway at safe distance above or below the lock to connect the river and bayou. This leads back to the subject of converting the lakes into a reservoir, upon which a few more words properly may be said here.

The present ratio of flood to low-water discharge in the neighborhood of Shreveport is very great, perhaps as much as 70 to 1 for extreme cases. Now, it may be possible to draw off a portion of the flood, say at Cottonwood Bayou or above, by regulating weirs and sluices, and redeliver it at the same place or below and so reduce the ratio as low as we choose, reservoir capacity and cost being the limiting factors, thereby improving low-water navigation and saving banks from excessive scour, without, however, materially weakening the channel-maintaining power of the river. For example, we may suppose the river rising to flood and that 10 per cent drawn off for ten days or so would keep it below danger line, while raising the lake surface but a few decimeters. A fill of 3 decimeters (say 1 foot) would allow an increase of the low-water discharge of about 100 per cent for not less than thirty days of extreme low water, and much longer for average conditions, changing the ratio to 35 to 1. The ideal condition would be to reduce to a mean stage throughout the year, and the practical to maintain a stage that would give a navigable depth of not less than 10 feet over the shoals at all times. This idea bears no relation to outlets, but suggests conservation of energy, storing up surplus water and utilizing it by proper control afterwards; in short, reasonable discipline of the river.

Outlets, on the contrary, would take flood water from a river and send it back below to swell a weakened stream still in flood; or to overpower another stream taxed to its full capacity by its own waters, or to be wasted wholly; in every case diminishing the channel-making power of the depleted stream and impairing its navigation, without ultimately reducing the high-water limit, but probably raising it.

Of course, no such plan as suggested could be undertaken with the information at hand, but there are possibilities in the idea worthy of study in considering the best means of improving Red River, and it would be profitable as well as interesting to expend a considerable sum to develop this survey in connection with that of Red River, to cover the wild country between the river and the hills to the west to ascertain how large an area of lake and swamp, but lately always submerged at higher stages, could be utilized for reservoir without encroaching upon tillable land or requiring high embankments to confine.

It is these considerations that have influenced the submission of the estimate of $375,000 for the plan of slack-water navigation from Red River to Jefferson through Cottonwood Bayou, and there is little hope of making it permanent except by a combination according to the ideas suggested, in which the improvement to Jefferson would become only an incident.

Considering the needs of Jefferson alone, I should recommend improving the present bayou channel from Jefferson to the head of Twelvemile Bayou by removing the logs and cypress stumps, widening it by dredging, easing the curves, clearing the banks of the bayou of leaning timber, and marking the channel by clusters of piles, beacons, and buoys. This route would be navigable for boats that could cross the Albany Flats; and since there are no questions of drainage or discharge to be considered, the route could be shortened by cut-offs at every practicable place. With the route thus improved the only danger to navigation would be that of being blown out of the channel by high winds, which, however, could not be avoided even with slack-water navigation.

The estimate of the importance of improving navigation between Jefferson and Red River depends upon the point of view. The small amount of business reported during the past few years seems hardly commensurate with the cost of a slack-water system that would entail a heavy annual charge for operating and maintenance, and of which the probable life is uncertain. On the other hand the people of Jefferson would hardly be satisfied with an improvement, however wide and deep the channel might be made, that could be used only when boats could cross the Albany Flats, which any attempt to cut through, even if supplemented by wing dams with expectation of holding up the pool, would only result in lowering the lake surface and draining it more rapidly.

Jefferson, once a distributing point for a large territory, had a great river and and wagon trade, which was possible because the damming of Red River by the raft held up the lake level, and because there was no other means of transportation to and from that port except by pack and wagon trains. The destruction of the raft and subsequent improvement of Red River made the water transportation dependent upon certain stages of Red River not always coincident with the needs of business, and the extension of railroads west and south gave a greater number of distributing points more convenient to the people that were developing the country, so that the rise and fall of Jefferson as a commercial center is not at all strange. It is difficult to get accurate information about the value of the business done at Jefferson since the greater part is railroad business either of transportation to or from, or local expenditures. The wharves and buildings that were on the bayou when the water route was the chief dependence have been abandoned and have gone to decay, and the business part of the town has moved towards the railroads. Jefferson has a population of about 3,000 and is on the eastern division of the Texas and Pacific Railway, connecting Texarkana and Marshall, about 16 miles north of the latter, which is on the main line from New Orleans to Shreveport and Fort Worth. It is also the eastern terminus of the Sherman, Shreveport and Southern Railway. A line has been surveyed lately for a new road from Texarkana to Shreveport to cross the lake near Mooringsport about 10 miles west of the site of the proposed dam, with some likelihood of being built within a year or two. But all of these roads, present and proposed, doubtless will be under the same general system, so that while Jefferson should have adequate facilities for transportation competition practically would be nil, and, therefore, a permanent water route is urged to regulate freight tariffs.

The commercial statistics given with the report on Red River show the business of Cypress Bayou, so far as could be learned by persistent inquiry, and include the fiscal years since July 1, 1889, when a more systematic plan was begun to get the information. No doubt the business would increase if navigation were assured even only in early spring when supplies are most in demand and in the autumn when cotton is the chief shipment, and if only the slack-water route bore promise of lasting beyond a decade the work would be recommended even at greater cost than the estimate.

The amount of money expended upon Cypress Bayou and the lakes by the city of Jefferson before the work was assumed by the United States was reported as $60,000, raised by subscription or self-imposed taxation. A crane or dipper dredge had been purchased and considerable work had been done before 1872, after which the plant was lent to the United States Engineer in charge. In 1876, the hull being decayed and racked, the dredge sunk, and in the following year the machinery was bought from the city, taken from the wreck, and put into a new hull, and in 1887 the dredge was rebuilt again. Last winter the machinery was taken down and the hull hauled out and thoroughly repaired and worn parts of the machinery replaced by new, so that the dredge is now as effective as ever and should do four or five years' more work if kept in condition. It has been used on so many different works, each of which has contributed to care and maintenance, that now it may be regarded as belonging to the general plant of the district rather than to Cypress Bayou alone. If dredging should be preferred for Cypress Bayou there are certain parts that could be done best by this machine, particularly in the bayou itself, but in the lakes where a wider channel is needed a dredge of the Hercules type, like those used on Lake Ponchartrain embankment, would be more effective, delivering the spoil at safe distances on either side the cut to form dikes or training walls. Such a dredge would cost about $30,000, with running expenses, including current repairs, about $1,500 the month.

The appropriations by the United States were as follows:

| By act of— | |
|---|---|
| June 10, 1872 | $10,000 |
| March 3, 1873 | 50,000 |
| August 14, 1876 | 13,000 |
| June 18, 1878 | 15,000 |
| March 3, 1879 | 6,000 |
| August 5, 1886 | 18,000 |
| August 11, 1888, allotted from appropriation for Red River | 5,000 |
| September 19, 1890, for survey | 10,000 |
| July 13, 1892, for survey | 2,000 |
| July 13, 1892, allotted from appropriation for Red River "in discretion of the Secretary of War" | 5,000 |
| Total | 134,000 |

The last allotment has not yet been expended, it having been thought best to wait till the completion of the maps to decide what should be best to do.

The survey was made on the same high grade as that of Red River, to which it is a valuable supplement, being connected with it through common monuments for triangulation and elevations. The notes have been tabulated and indexed, and so many permanent marks were established in both surveys, some of which can not fail to last, that comparison with future surveys should be easy.

Many early surveys have almost no present value for want of a few permanent marks, and the engineers who made them having gone to other fields, the finding of any trace of their work is generally a matter of unexpected good fortune. The engineers of the Delta Survey chose trees along the road or on caving banks for their bench marks, passing monumental buildings with averted faces, to judge by their notebooks, which contain no sketches of bench or triangulation marks; while if "strict economy" had not been spared to use no more than $500 of the many thousands expended, their maps might have taken rank for accuracy with those of the Commission and have been of the highest value for comparison.

Whether this survey shall lead to a permanent improvement of Cypress Bayou or save a fruitless expenditure, its value to the future improvement of Red River alone fully justifies the time and money devoted to it. The work has been well done, and offers a solid foundation of fact for future development. If the conclusions are not sufficiently encouraging, some later engineer, more sanguine than I and helped by conditions more favorable than I have anticipated, may succeed in giving the desired "permanent deep water to the gulf" without being hampered by considerations of Red River navigation. Except as I have indicated it does not seem possible to give a permanent route from Jefferson to Red River, unless by an independent canal.

The maps* on scale 1:10,000, with index chart* on scale 1:50,000, itself a complete map of Cypress Bayou, are not surpassed by any issued by the Engineer Department or by the Commissions to the present time. The original sheets are on the best handmade Whatman paper that could be got when they were projected (date 1889, paper of 1871 found since), with circular protractors printed from the engraved plate in the office of the Chief of Engineers. Plotting, outlines, and lettering are fine hand work, while the topography was printed by the mechanical process so well developed by Assistant Engineer Ockerson in following out Capt. Leach's ideas, which has been described in reports of the Chief of Engineers since 1884.

The cost of tracing only in outline to furnish blue prints for working drawings, to say nothing of that for making duplicates, being very considerable, it occurred to me that celluloid negatives might be made at less expense which should be as durable as tracing linen, with the advantage that any kind of print might be made, ferro, bromide, etc., on a white ground that would be an exact copy. This suggested that transformations of scale could be effected by the same means at a great saving of time and expense over the method of squares or with pantograph. Experiments were made in printing directly through the drawing and in making negatives by contact of full size with considerable success. For strong line drawings on semitranslucent paper the former method will do very well when time presses. The latter method answered every expectation when bromide paper was used for the contact negative, but was unhandy for large maps. In the meantime inquiry was made of Lieut. Col. King, commanding the Engineer School of Application, about the practical details of making celluloid films of large size to accurate scales. Having exceptional facilities at the photographic laboratory of the school in apparatus and skillful operators, the colonel finally undertook the task of making negatives to one-half the original scale, giving sheets one-fourth the size of the maps.

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* Not printed.

The experiment was highly successful, the photographic reduction being so carefully adjusted as not to give a variation in the bromide prints greater than about 1 per cent, or no more than would be produced by the expansion and contraction of the paper by atmospheric changes; say 4 millimeters (about sixteen-hundredths of an inch) in the length of the reduced map sheet. The chief item of cost for an outfit to do this kind of work well is the lens, which should be the best made, and therefore, and because the manipulation requires considerable experience, it is not recommended except to officers who are practical photographers, or who are stationed in or near large cities. Possibly it might be advisable to enlarge the operations at Willets Point so as to do such work at short notice, the cost to be borne by the officers ordering it.

It is proper to mention here the interest and care taken in the experiment by Col. King and the operators. The maps are exact reproductions, and in tone and finish are very nearly works of art, and show how high the standard of excellence has been raised at the Engineer School.

The cost of the seventeen films from which any number of prints may be made, and two full sets of bromide prints, was about one-third of that estimated for ordinary outline tracings, and one sixth of that which would have been required for reducing to half-scale and outline tracings for printing. In either case the topographical signs could not have been put on by mechanical process, but would have had to be done by hand, increasing the cost not less than 50 per cent.

### *Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $6.01 |
| Amount appropriated by act approved July 13, 1892 | 2,000.00 |
| | 2,006.01 |
| June 30, 1893, amount expended during fiscal year | 1,930.34 |
| July 1, 1893, balance unexpended | 75.67 |
| July 1, 1893, outstanding liabilities | 16.72 |
| July 1, 1893, balance available | 58.95 |

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## REPORT OF ASSISTANT ENGINEER H. M. MARSHALL.

UNITED STATES ENGINEER OFFICE,
*Vicksburg, Miss., June 27, 1893.*

CAPTAIN: I have the honor to report on survey of Cypress Bayou and the lakes between Jefferson, Tex., and Shreveport, La.

The principal fieldwork was done between December 6, 1890, and April 15, 1891, having suffered interruption by high water during February and March. A more extended topographical examination of Cottonwood Bayou was made, together with borings in Sodo Lake, between November 17 and December 12, 1892. The borings were made by repeated drives of ordinary 1¼-inch wrought iron well pipe, with the lower end open. When the pipe had become plugged so that it would not take more material by further driving, it was pulled and the bottom section replaced with a new section and the pipe inserted in the same hole. The bottom sections were numbered when pulled and the ends closed with metal plugs. These sections were cut in decimeter lengths, and the material examined and placed in tubes at the office. The driving being in water, a short section of pipe of large diameter was used to prevent inflow and to facilitate replacing the pipe in the hole. The greatest depth driven was 11.35 meters, and average depth about 10 meters. The bed of the lake to a depth of 8 meters consists of stiff clay, usually red, but with frequent irregular changes to blue or greenish. Below the clay is fine red sand, changing to coarse yellow and white at varying depths.

The methods of survey were the same as practiced on Red River, to which reference is made for a more extended description. Map sheets* have been plotted; scale, 1:10,000, and index chart*, 1:50,000. The data gathered by the survey are shown in tabulated form under appropriate headings.

Comparison of sections in Red River, 1872, 1887, 1893, near head of Cottonwood Bayou, have been plotted, and are worthy of publication because they show better than can otherwise be made clear how the river bed has changed. The soundings of early surveys are too few in Sodo Lake and Twelve Mile Bayou to justify publication; but it can positively be asserted they show only small fill in the lake and local scour in the bayou increasing downstream. There is no record by which the relative elevation of the water surface in the lakes and at Shreveport in former times can be compared with the present, except the elevations of high-water marks and the water surface face that obtained at time of the surveys. The former can be found in the table of high-water marks, and the latter are given in the following table:

*Elevation of water surface at different periods.*

| Date. | Water surface above Cairo datum. | | Fall. |
|---|---|---|---|
| | Albany Point. | Shreveport. | |
| | *Meters.* | *Meters.* | *Meters.* |
| Oct. 20, 1867 | 56.47 | Not known | .......... |
| Feb. 5, 1872 | 58.63 | 55.67 | 2.96 |
| Mar. 11, 1872 | 57.81 | 54.52 | 3.60 |
| Jan. 20, 1874 | 57.38 | 53.85 | 3.53 |
| Feb. 16, 1874 | 58.57 | 56.05 | 2.52 |
| Dec. 24, 1890 | 57.06 | 52.20 | 4.86 |
| Dec. 27, 1890 | 56.76 | 51.77 | 4.99 |

No change in the relative water-surface elevations appears to have taken place, and the draining of the lakes during low-water season, which is testified to most vociferously by "the oldest inhabitants," must be taken as concomitant with the lowering of the low-water plane in Red River.

The bottom of Sodo Lake and Twelve Mile Bayou with reference to zero of the Shreveport gauge is as follows: About the Gate Posts, 7 meters above; Albany, 3 meters above; Grindstone Bluff, 1 meter above; between head and foot of Horton Chute, 2.5 to 4 meters above, and thence to the mouth, 1 to 7 meters below, with the shoal water nearest the mouth. At time of sounding the river was 3.5 meters above zero, or about 4 meters above extreme low water, and there was 3 meters least depth to Albany; but with so great fall in the channel bottom from the Gate Posts to foot of Horton Chute, a distance of 13 kilometers, and only 24 cubic meters' discharge at low water, it can confidently be said that but small depth would have been found had the latter stage obtained. All of this only confirms what was long ago clearly stated by Maj. Howell in regard to a lock at Albany, to wit: "That without the interposition of a second lock and dam between the first and Shreveport in low water the bayou below Albany Point for a distance of nearly 6 miles would run dry." (Report Chief of Engineers, 1890, p. 1918.) An unlimited water supply drawn from above the lock could only make an unstemable current, because of the excessive slope. The inutility of the much talked of "Leavenworth section to Gold Point" in conjunction with a dam at Albany Point, is sufficiently shown by the following table of water surfaces and channel bottom elevations at the former place, when it is remembered that the zero of Jefferson gauge is 57.12 meters Cairo datum:

---

* Not printed.

| Date. | Gold Point. | | Shreveport. | Fall. |
|---|---|---|---|---|
| | Channel bottom. | Water surface. | Water surface. | |
| Oct. 21, 1867 | .......... | 56.7 | .......... | .......... |
| Feb. 13, 1872 | 54.1 | 59.1 | 55.59 | 3.51 |
| Feb. 11, 1887 | 51.6 | 58.7 | 50.90 | 7.80 |
| Oct. 27, 1892 | 49.7 | 56.5 | 50.19 | 6.31 |

Since the slope from Albany Flats to Shreveport is too great to permit dredging an open cut, and the necessity for two sets of locks and dams makes canalization of Twelve Mile Bayou too costly, there is nothing left but to transfer the "Leavenworth section" idea upstream to a point where the water in Red River is higher at all times than the low water at Jefferson. An element of uncertainty enters in the selection of the proper point, due to the lack of record of the low-water elevations anywhere in this region.

Cottonwood Bayou is the first probable location for a connection with Red River, and as far as is known would comply with the requirements as to low-water elevation, though it is barely within the mark. The lowest ascertained water at the head of Cottonwood Bayou was 59.31 meters Cairo datum in 1874. The river possibly has been lower than this in late years, and in fact may regularly every year go as low, but no gauge was set or record kept before November, 1892. Possibly the fill in the bed of the outlets above, since 1874, has concentrated in the river water which formerly escaped to the lakes at low stages, so that the lowering of the low-water plane at and above Cottonwood Bayou may be insignificant. Whatever the changes in the past there would be no certainty of their constancy or continuance in the future, and it would take long and careful observation to foretell the probable lapse of time before navigation to Jefferson would be again suspended at low water. While it is not practicable, by reason of increase in height of the river above the lakes at other stages, to go far enough upstream to render the lowering of the low-water plane below zero of Jefferson gauge a remote possibility, yet navigation through Cottonwood Bayou need not immediately cease should that contingency befall. The variation in relative elevations of water surface in the lakes and Red River, as may be seen in the table below, precludes the possibility of continuous open Navigation even at Cottonwood Bayou.

*Simultaneous elevation of water surfaces at Jefferson, head of Cottonwood Bayou, Sodo Lake, and Shreveport.*

| Date. | Meters above Cairo datum. | | | |
|---|---|---|---|---|
| | Jefferson. | Head of Cottonwood Bayou. | Sodo Lake. | Shreveport. |
| Dec. 24, 1892 | 61.57 | *63.68 | 60.14 | 57.17 |
| Dec. 29, 1892 | 61.40 | 63.64 | *60.59 | 57.90 |
| Jan. 1, 1893 | 61.60 | 63.58 | 60.51 | *58.62 |
| Jan. 5, 1893 | *62.58 | 63.54 | 60.23 | 57.60 |
| Feb. 15, 1893 | †58.12 | †61.80 | †57.64 | 52.28 |
| Lowest water recorded | 57.12 | 59.31 | 56.53 | 48.54 |

* Highest since November, 1892. † Lowest since November, 1892.

Without a lock at its head the slope down the bayou, except at low stages, would be too great, since the distance from river to lake, now but 10 kilometers, would be shortened half by backwater, for the height of the weir in the lake must be limited by the land allowable for submergence. A lock, however, would be clearly to the advantage of river improvement, in that there would be no water drawn from the river except the small quantity needed for locking, and it would be an aid to the levee system in averting overflow. So long as low water in Red River does not fall too low, that is below the height of 1874, if the crest of the weir in the lake should be put at 60 meters Cairo datum, navigable water 2 meters deep would obtain all the way to Jefferson. One meter more would be found when the water at the head of the lock was level with or above the top of the weir. By building the lock with double sets of gates so that the lift could be either from lake or river, the surplus water stored in the lakes above the amount needed to afford the desired depth could be utilized in locking and the period of navigability prolonged to least required depth on the miter sill.

The area of Sodo Lake above the present foot of Cottonwood Bayou, with that of Clinton, Clear, and Ferry lakes and James Bayou, is 1,500,000,000 square meters. One meter depth over this reservoir would supply 100 cubic meters discharge per second for one hundred and seventy days, or serve to treble the flow of Red River nearly the whole low-water season without hindrance to the improved navigation to Jefferson. Briefly, the plan should embrace a weir across Sodo Lake, near Cottonwood Bayou, built of timber, guide piles with rows of sheet piling, with crest 350 meters long at 60 meters elevation, a levee 1 meter above high water from the ends of the weir to the hill on the west, and along the southeast bank of Cottonwood Bayou about half way out to Red River, where the banks have the same elevation as that proposed for the weir crest; thus no "backing up" would be caused by the weir and levee at high stages; a head and tail wall, built of brick and faced with vitrified paving brick, inclosing a short section of the bayou, within which the banks should be paved to serve as a lock chamber; a double set of lock gates; and the bayou to be cleared of timber and drift. No dredging would be needed. The following is the estimated cost:

| | |
|---|---|
| Weir 350 meters in length | $50,000 |
| Embankment | 125,000 |
| Lock walls and gates | 100,000 |
| Bank paving, clearing, etc | 50,000 |
| Engineering and contingencies | 50,000 |
| | 375,000 |

Very respectfully, your obedient servant,

H. M. Marshall,
*Assistant Engineer.*

Capt. J. H. Willard,
*Corps of Engineers, U. S. A.*

**Table 1.**—*Tabulated results of the tertiary triangulation of Cypress Bayou and the lakes from Shreveport, La., to head of Ferry Lake, Texas.*

[Assistant Engineer T. C. Thomas, chief of party; F. Y. Parker, observer; Charles H. Schermerhorn, leveler.]

[Note.—Elevations are referred to the Cairo datum, and each elevation applies to the first of the △'s standing opposite.]

| Side. | Distance. | Azimuth. | Elevation. | Side. | Distance. | Azimuth. | Elevation. |
|---|---|---|---|---|---|---|---|
| | *Meters.* | ° ′ | *Meters.* | | *Meters.* | ° ′ | *Meters.* |
| W. B.—E. B | 704.3 | 296 45 | 58.37 | 12—9 | 1,073.8 | 310 02 | ........ |
| E. B.—2* | 707.8 | 62 54 | 59.83 | 9—11 | 1,427.3 | 181 55 | ........ |
| 2—W. B | 639.4 | 180 06 | 58.44 | 11—12 | 1,139.8 | 49 47 | ........ |
| 2—2a | 603.4 | 170 25 | ........ | 12—14 | 1,478.3 | 185 28 | ........ |
| 2a—E. B | 779.7 | 290 28 | ........ | 14—11 | 1,035.9 | 315 16 | ........ |
| E. B.—1 | 931.7 | 178 58 | ........ | 11—13 | 1,747.5 | 178 41 | ........ |
| 1—2a | 971.5 | 47 17 | ........ | 13—14 | 1,223.5 | 34 16 | ........ |
| 2a—4 | 983 | 170 47 | ........ | 14—16 | 826.2 | 127 42 | ........ |
| 4—1 | 925.2 | 289 40 | 59.60 | 16—13 | 1,434.8 | 249 21 | ........ |
| 1—3 | 1,161.7 | 168 30 | ........ | 13—15 | 2,073.5 | 108 18 | ........ |
| 3—4 | 1,045.7 | 37 44 | ........ | 15—16 | 1,315.8 | 331 36 | ........ |
| 4—6 | 1,133.7 | 165 34 | ........ | 16—16a | 836 | 81 49 | ........ |
| 6—3 | 961.5 | 286 22 | 59.75 | 16a—15 | 1,292.4 | 188 59 | ........ |
| 3—5 | 1,152.5 | 173 01 | ........ | 15—18 | 1,726.6 | 45 55 | ........ |
| 5—6 | 1,172.3 | 41 52 | ........ | 18—16a | 1,041.5 | 274 08 | ........ |
| 6—8 | 1,233.5 | 168 40 | ........ | 16a—17 | 1,403.5 | 125 47 | 59.57 |
| 8—5 | 1,078.6 | 288 10 | ........ | 17—18 | 752.3 | 352 23 | ........ |
| 5—7 | 1,106.5 | 169 08 | ........ | 17—19 | 769.5 | 102 08 | ........ |
| 7—8 | 1,108.7 | 47 24 | ........ | 19—18 | 1,244.7 | 316 48 | ........ |
| 8—10 | 1,430.5 | 168 14 | ........ | 18—20 | 1,117.5 | 90 31 | ........ |
| 10—7 | 1,248.7 | 300 24 | ........ | 20—19 | 935.8 | 196 29 | 58.44 |
| 7—9 | 1,342 | 172 16 | ........ | 20—22 | 1,699.9 | 146 16 | ........ |
| 9—10 | 1,150.1 | 53 46 | ........ | 22—19 | 1,315.1 | 293 07 | 57.09 |
| 10—12 | 1,374.6 | 184 25 | ........ | 19—21 | 1,380.8 | 162 44 | ........ |

* Shreveport base line.

**TABLE 1.**—*Tabulated results of the tertiary triangulation of Cypress Bayou and the lakes from Shreveport, La., etc.*—Continued.

| Side. | Distance. | Azimuth. | Elevation. |
|---|---|---|---|
| | *Meters.* | ° ′ | *Meters.* |
| 21—22 | 1,132.8 | 44 55 | .......... |
| 21—23 | 1,163.8 | 131 55 | .......... |
| 23—22 | 1,581.2 | 357 36 | 57.50 |
| 22—24 | 1,215.2 | 126 27 | .......... |
| 24—23 | 1,251.7 | 226 43 | 56.50 |
| 23—25 | 1,218.8 | 91 54 | .......... |
| 25—24 | 949.6 | 341 08 | 57.44 |
| 24—26 | 1,476.9 | 87 49 | .......... |
| 26—25 | 1,509.3 | 230 45 | .......... |
| 26—26*a* | 1,439.2 | 135 16 | .......... |
| 26*a*—25 | 2,182.6 | 271 46 | .......... |
| 25—27 | 1,986.3 | 122 25 | .......... |
| 27—26*a* | 1,118 | 26 51 | 58.47 |
| 27—28 | 1,562.1 | 89 18 | .......... |
| 28—26*a* | 1,440.4 | 312 47 | 57.76 |
| 26*a*—29 | 2,423.4 | 167 56 | .......... |
| 29—28 | 1,496.1 | 21 33 | 57.80 |
| 28—30 | 2,498.9 | 128 59 | .......... |
| 30—29 | 2,498.9 | 274 08 | 57.55 |
| 29—31 | 2,267.1 | 138 43 | .......... |
| 31—30 | 1,820.3 | 33 12 | .......... |
| 31—31*a* | 1,642.3 | 90 04 | .......... |
| 31*a*—30 | 1,656.2 | 337 02 | .......... |
| 30—32 | 2,582.7 | 122 11 | .......... |
| 32—31*a* | 1,546.9 | 264 28 | .......... |
| 32—33 | 2,205.5 | 196 23 | .......... |
| 33—31*a* | 2,170 | 334 59 | .......... |
| 31*a*—34 | 3,589.1 | 119 40 | .......... |
| 34—33 | 2,209.7 | 265 02 | .......... |
| 33—35 | 3,072.6 | 150 27 | .......... |
| 35—34 | 2,945.4 | 13 28 | .......... |
| 34—36 | 3,162 | 144 00 | .......... |
| 36—35 | 2,563.5 | 263 08 | .......... |
| 35—37 | 3,682.3 | 125 11 | .......... |
| 37—36 | 2,472.1 | 349 10 | .......... |
| 36—39 | 2,658.7 | 133 33 | .......... |
| 39—37 | 1,578.8 | 247 49 | .......... |
| 37—38 | 2,192.6 | 36 09 | .......... |
| 38—39 | 1,186.5 | 171 50 | 68.20 |
| 39—40 | 2,119 | 39 02 | .......... |
| 40—38 | 1,575.1 | 252 34 | 68.551 |
| 38—41 | 2,772.8 | 112 54 | .......... |
| 41—40 | 1,873.9 | 325 52 | 65.37 |
| 40—42 | 3,129.3 | 110 47 | .......... |
| 42—41 | 1,925.2 | 256 45 | 66.64 |
| 41—43 | 3,003.6 | 168 09 | .......... |
| 43—42 | 3,607.2 | 20 24 | 62.33 |
| 43—43*a* | 3,083.1 | 83 49 | .......... |
| 43*a*—42 | 3,544.3 | 329 20 | 61.41 |
| 42—45 | 4,583.8 | 106 30 | .......... |
| 45—43*a* | 3,122.2 | 235 58 | .......... |
| 43*a*—44 | 5,366.9 | 11 40 | .......... |
| 44—45 | 3,816.6 | 156 49 | 67.97 |
| 45—46 | 7,046.2 | 53 38 | 61.19 |
| 46—44 | 7,207.8 | 264 38 | 61.98 |
| 44—47*a* | 5,489.7 | 115 15 | .......... |
| 47*a*—46 | 3,741 | 36 14 | 73.87 |
| 47*a*—48 | 3,562.2 | 88 02 | .......... |
| 48—46 | 3,193.6 | 335 01 | 59.73 |
| 46—49 | 4,329.5 | 196 01 | .......... |
| 49—48 | 2,841.6 | 63 32 | .......... |
| 48—50 | 3,313.2 | 183 59 | .......... |
| 50—49 | 3,083.8 | 311 23 | 60.01 |
| *Azimuth lines.* | | | |
| *R. P. "H."—R. P. "G." | 505 | 63 06 | 69.44 |
| *R. P. "E."—R. P. "F." | 359 | 314 12 | 62.20 |
| *R. P. "A"—R. P. "B." | 932.5 | 226 23 | 75.98 |

* See table 4 for descriptions.

## TABLE 2.—*Precise levels.*

[Observer: R. S. Buck.]

### INSTRUMENTAL CONSTANTS.

*Table A.*

| Kern level. | Pivot correction for a distance of 1 meter. | Date of determination. |
|---|---|---|
| | *Millimeter.* | |
| M. R. C. No. 2 | —0.001 | Oct. 22, 23, 1890. |

*Table B.*

| Bubble tube. | Value of one division for a distance of 1 meter. | Date of determination. |
|---|---|---|
| | *Millimeter.* | |
| No. 2 | 0.015 | Oct. 22, 23, 1890. |

*Table C.*

| Rod. | Length of 1 meter on rod. | Correction for spur. |
|---|---|---|
| | *Millimeters.* | *Millimeters.* |
| II | *999.866 | +47.5 |
| IV | *999.890 | +48.2 |

* Mean of Lake Survey and Mississippi River Commission determinations. See M. R. C., Rep. 1881, p. 51.

*Tabulated results.*

SHREVEPORT, LA., TO JETER LANDING, LOUISIANA.

| Bench. | Distance— Between bench marks. | Distance— From Shreveport. | Difference of elevation. North. | Difference of elevation. South. | Difference of elevation. Mean. |
|---|---|---|---|---|---|
| | *Kilometers.* | *Kilometers.* | *Meters.* | *Meters.* | *Meters.* |
| P. B. M. 46 | ........ | ........ | ........ | ........ | ........ |
| T. B. M. 1 | 0.69 | 0.69 | − 7.0009 | − 7.0013 | − 7.0011 |
| 2 | 1.17 | 1.86 | − 0.8073 | − 0.8124 | − 0.8099 |
| 3 | 1.76 | 3.62 | + 0.8638 | + 0.8607 | + 0.8622 |
| 4 | 2.39 | 6.01 | − 2.3193 | − 2.3241 | − 2.3217 |
| 4*a* | 0.31 | 6.32 | *+ 0.3062 | + 0.2847 | + 0.2954 |
| 5 | 0.98 | 7.30 | +10.1955 | +10.1944 | +10.1949 |
| 6 | 1.16 | 8.46 | + 3.4135 | + 3.4135 | + 3.4135 |
| 7 | 1.65 | 10.11 | − 2.8952 | − 2.8944 | − 2.8948 |
| 8 | 1.95 | 12.06 | + 3.6794 | + 3.6800 | + 3.6797 |
| 9 | 2.12 | 14.18 | − 3.9118 | − 3.9091 | − 3.9104 |
| 10 | 1.55 | 15.73 | + 7.9151 | + 7.9149 | + 7 9150 |
| 11 | 1.39 | 17.12 | − 7.8436 | − 7.8419 | − 7.8428 |
| 12 | 1.96 | 19.08 | + 6.7237 | + 6.7240 | + 6.7238 |
| 13 | 1.34 | 20.42 | + 1.7363 | + 1.7366 | + 1.7364 |
| 14 | 1.34 | 21.76 | + 5.3894 | + 5.3904 | + 5.3899 |
| 15 | 1.76 | 23.52 | + 6.6736 | + 6.6771 | + 6.6753 |
| 16 | 1.70 | 25.22 | + 2.4728 | + 2.4729 | + 2.4720 |
| 17 | 1.05 | 26.27 | − 3.4294 | − 3.4263 | − 3.4278 |
| 18 | 1.76 | 28.03 | + 5.0380 | + 5.0389 | + 5.0385 |
| 19 | 1.41 | 29.44 | − 8.4270 | − 8.4260 | − 8.4265 |
| 20 | 1.40 | 30.84 | + 2.1107 | + 2.1070 | + 2.1089 |
| 21 | 1.32 | 32.16 | −23.6947 | −23.6980 | −23.6963 |
| 22 | 0.51 | 32.67 | + 6.7803 | + 6.7797 | + 6.7800 |
| 23 | 0.85 | 33.52 | +28.4802 | +28.4791 | +28.4796 |
| 24 | 1.52 | 35.04 | − 6.4433 | − 6.4390 | − 6.4411 |
| 25 | 1.12 | 36.16 | − 0.3239 | − 0.3187 | − 0.3213 |
| 25*a* | 0.70 | 36.86 | −12.7451 | −12.7461 | −12.7456 |
| 26 | 1.34 | 38.20 | − 7.4387 | − 7.4393 | − 7.4390 |
| 27 | 1.42 | 39.62 | + 8.6524 | + 8.6497 | + 8.6510 |
| 28 | 1.59 | 41.21 | − 7.4335 | − 7.4294 | − 7.4314 |
| 29 | 0.71 | 41.92 | − 1.0841 | − 1.0815 | − 1.0828 |
| 30 | 1.59 | 43.51 | − 3.8144 | − 3.8110 | − 3.8127 |
| P. B. M. 4 | 0.03 | 43.54 | − 0.8536 | − 0.3536 | − 0.3536 |
| *Side line.* | | | | | |
| T. B. M. 20 | ........ | 30.84 | ........ | ........ | ........ |
| 20*a* | 1.03 | 31.87 | − 2.1966 | − 2.1969 | − 2.1967 |
| 20*b* | 1.09 | 32.96 | − 5.9563 | − 5.9538 | − 5.9550 |
| 20*c* | 0.94 | 33.90 | + 3.8755 | + 3.8755 | + 3.8755 |
| P. B. M. 2 | ........ | ........ | − 0.7780 | − 0.7780 | − 0.7780 |

* River crossing.

## TABLE 3.—DESCRIPTIONS AND ELEVATIONS OF PRECISE BENCH MARKS FROM SHREVEPORT, LA., TO JETER LANDING, LA.

[NOTE.—All bench-mark monuments, when not otherwise described, consist of pieces of limestone 46 centimeters square and 15 centimeters thick, marked U. S. ○ B. M. with spherical-headed copper bolts leaded in upper faces, and buried 1.2 meters under ground, access being given through 12-centimeter iron pipes set on top. Each pipe has a cast-iron cover, fastened by a horizontal bolt through cap and pipe. The cap has a small boss and the letters U. S. E ○ B. M. raised on top. Elevations are expressed in meters above the Cairo datum and apply to the top of the bolt in the underground stone. Elevation of boss of pipe can be found in any case by adding 1.24 meters to elevation of copper bolt.]

P. B. M. 46: In northwest corner of yard of the public building at Shreveport, La. Bench is 1.3 meters east and 0.5 meter south of fence corner, and 28 meters north of northwest corner of building. Elevation, 65.845.

P. B. M. 1: At Albany Point, Caddo Parish, La. Is in the northeast corner of yard, 10.3 meters from northeast corner of house; 16 meters from edge of bluff; 10 meters northwest of a cedar tree. Elevation, 74.113.

P. B. M. 2. At Henderson Hill, Caddo Parish, La. [illegible] is on the [illegible] north side of [illegible] meters from northwest [illegible] meters from corner of [illegible] 20 meters from edge of bluff [illegible] together at the [illegible] P. B. M. [illegible] Elevation, [illegible]

P. B. M. 3. At [illegible], Caddo Parish, La. Is on the north side of [illegible] meters from northwest corner of [illegible] meters from northwest corner of [illegible] meters from top of [illegible] Lake. Elevation, [illegible]

P. B. M. 4. At [illegible] Landing, Caddo Parish, La. Is on line of east side of [illegible] meters from northeast corner [illegible] meters from edge of bluff [illegible] north and south line [illegible] meters from [illegible] Elevation, [illegible]

TABLE 8.—DESCRIPTIONS AND ELEVATIONS OF BENCH MARKS FROM SHR
LA., TO JEFFERSON, TEX.

([illegible] route.)

[NOTE.—Elevations are in meters above Gulf datum.]

B. M. 1. At Stump Point, on Ferry Lake, Harrison County, Tex. Is [illegible] corner of [illegible] building [illegible] with white brick chimney, on [illegible] south side of [illegible] meters from southeast corner. The elevation is [illegible] the top of [illegible] underground stone. Elevation of base of [illegible] can be [illegible] by adding [illegible] meters to the elevation of top of [illegible] Elevation, [illegible]

B. M. 2. At [illegible] Bluffs, Harrison County, Tex. Is same as R. P. [illegible] meters west of [illegible] on top of bluffs. Is cross [illegible] cut in cement filling of [illegible] pipe. Elevation, [illegible]

B. M. 3. At Port Caddo, Harrison County, Tex. Is 30 meters south of Mr. [illegible] house, [illegible] kilometer east of Port Caddo Landing; is cross [illegible] cut in cement filling of vitrified pipe. Elevation, [illegible]

B. M. 4. Is [illegible] kilometer below Red Bluffs, on left bank of bayou, 4.5 kilome[illegible] above Port Caddo, Harrison County, Tex.; is same as R. P. "H." and is [illegible] cement filling of vitrified pipe. Elevation, [illegible]

B. M. 5. At foot of Red Bluffs, [illegible] meters from right bank of bayou, 5.0 kilome[illegible] above Port Caddo, Harrison County, Tex.; is same as R. P. "[illegible]" and is top of cement filling of vitrified pipe. Elevation, [illegible]

B. M. 6. At Benton Landing, Harrison County, Tex. Is on inside of yard fence [illegible] meters north of house and 25 meters from right bank of bayou; is same as R. P. "[illegible]" and is the top of cement filling of vitrified pipe. Elevation, 64.72.

Reference point "E." Is [illegible] kilometer above Benton Landing, Harrison Co[illegible] Tex.; 25 meters from right bank at [illegible] end of Benton Cut-off, in an old fie[illegible] meters from [illegible] of [illegible]; is the top of cement filling of vitrified p[illegible] Elevation, [illegible]

B. M. 7. At [illegible], Harrison County, Tex. Is on the out[illegible] of fence line 25 meters north of [illegible] on Mrs. [illegible] farm; is the same a[illegible] R. P. "[illegible]" and is the top of cement filling of vitrified pipe. Elevation, 62.[illegible]

B. M. 8. At Keene [illegible] Landing, Harrison County, Tex. Is on the out[illegible] of fence line [illegible] meters from corner of [illegible]; is same as R. P. "C." and is the [illegible] of cement filling of vitrified pipe. Elevation, [illegible]

B. M. 9. At Jefferson, Marion County, Tex. Is the letter "F" in the word "F[illegible]" on iron door-sill, northwest side of Walnut street, and the first door from co[illegible] of [illegible] street; is the same as Lieut. Woodruff's bench mark, survey of 1[illegible] Elevation, [illegible]

B. M. 10. At Jefferson, Marion County, Tex. Is star on iron door-sill, northe[illegible] side fourth door southwest of Citizens' Bank, Walnut street. Elevation, 61.54.

B. M. 11. At Jefferson, Marion County, Tex. Is cross [illegible] cut on south end of th[illegible] step from top of east Austin street entrance of United States Government build[illegible] Elevation, [illegible]

Reference point "A." At Jefferson, Marion County, Tex. Is in dooryard of pr[illegible] erty belonging to Mr. ——— [illegible], on west side of Texas street; 52 meters sou[illegible] east of corner of Texas and [illegible] streets, about [illegible] meters southwest of (colo[illegible] [illegible] Baptist Church. Is the southwest point of azimuth line and is top of cem[illegible] filling of vitrified pipe. Elevation, [illegible]

B. M. 12. Is across the bayou opposite Jefferson, Marion County, Tex.; in northe[illegible] corner of yard belonging to ——— [illegible], [illegible] meters north of east end of [illegible] bridge; is the same as R. P. "B," northeast point of the azimuth line and is cross [illegible] cut in cement filling of vitrified pipe. Elevation, [illegible]

# Cypress Bayou Survey P.B.M.

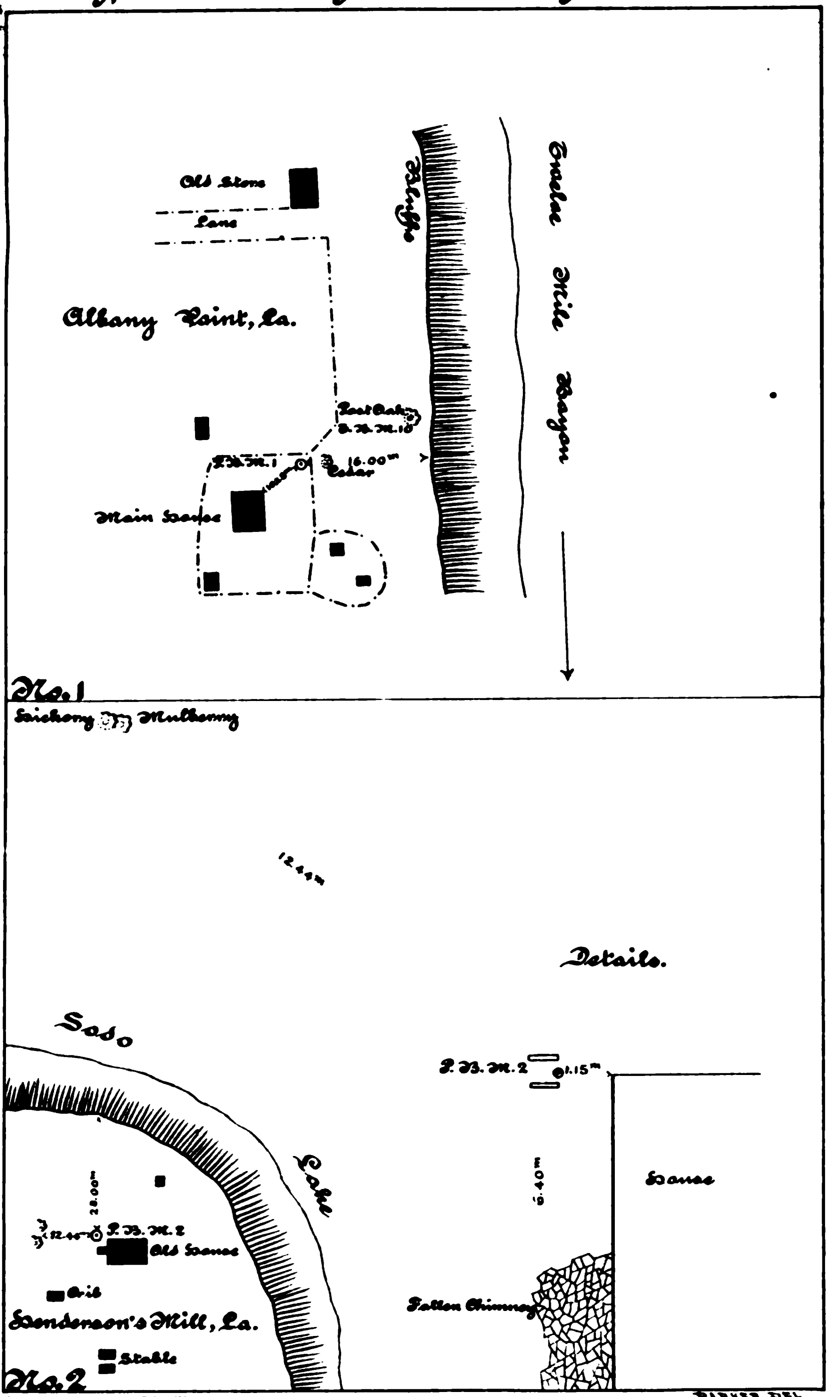

Photo-Lith. by A. Hoen & Co., Balto., Md.

[illegible] DEL.

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P. B. M. 2: At Henderson Mill, Caddo Parish, La., near upper end of Sodo Lake. Is on line with north side of deserted house, 1.0 meter from northwest corner; 6.4 meters from center of fallen stone chimney; 28 meters from edge of bluff; 12.4 meters southeast of mulberry and hickory trees grown together at the root. On north and south side of P. B. M. are buried on edge two mill stones. Elevation, 80.661.

P. B. M. 3: At Mooringsport, Caddo Parish, La. Is on the north side of C. S. Croom's store, 1.9 meters from northwest corner of gallery; 0.4 meter from edge of gallery; 0.6 meter from northwest corner of wall; 45 meters from top of bank of Ferry Lake. Elevation, 62.002.

P. B. M. 4: At Jeter Landing, Caddo Parish, La. Is on line of east side of deserted house 0.9 meter from northeast corner; 21.1 meters from edge of bluff measured on approximate north and south line; 25.6 meters from post oak tree at edge of bluff on which is T. B. M. 30. Elevation, 66.303.

### TABLE 4.—DESCRIPTIONS AND ELEVATIONS OF BENCH MARKS FROM SHREVEPORT, LA., TO JEFFERSON, TEX.

[Chas. H. Schermerhorn, leveler.]

[NOTE.—Elevations are in meters above Cairo datum.]

B. M. 1: At Starr Point, on Ferry Lake, Harrison County, Tex. Is at southeast corner of Capt. Starr's hunting lodge (cabin with white brick chimney), on line with south side of cabin and 0.6 meter from southeast corner. The elevation applies to the top of bolt in underground stone. Elevation of boss of pipe-cap can be found by adding 1.24 meters to the elevation of top of copper bolt. Elevation, 60.45.

B. M. 2: At Anna Glade Bluffs, Harrison County, Tex. Is same as R. P. "J.;" 10 meters west of cabin on top of bluffs; is cross (+) cut in cement filling of vitrified pipe. Elevation, 68.58.

B. M. 3: At Port Caddo, Harrison County, Tex. Is 30 meters south of Mr. Bunner's house, 0.3 kilometer east of Port Caddo Landing; is cross (+) cut in cement filling of vitrified pipe. Elevation, 71.40.

B. M. 4: Is 0.5 kilometer below Red Bluffs, on left bank of bayou, 4.5 kilometers above Port Caddo, Harrison County, Tex.; is same as R. P. "H.," and is top of cement filling of vitrified pipe. Elevation, 60.44.

B. M. 5: At foot of Red Bluffs, 1 meter from right bank of bayou, 5.0 kilometers above Port Caddo, Harrison County, Tex.; is same as R. P. "G.," and is top of cement filling of vitrified pipe. Elevation, 60.17.

B. M. 6: At Benton Landing, Harrison County, Tex. Is on inside of yard fence 15 meters north of house and 25 meters from right bank of bayou; is same as R. P. "F.," and is the top of cement filling of vitrified pipe. Elevation, 64.72.

Reference point "E:" Is 0.4 kilometer above Benton Landing, Harrison County, Tex.; 25 meters from right bank at lower end of Benton Cut-off, in an old field, 25 meters from skirt of timber along lake. Is the top of cement filling of vitrified pipe. Elevation, 62.2.

B. M. 7: At "Sisco" or Henckle Camp, Harrison County, Tex. Is on the outside of fence line 25 meters north of cabin on Mrs. Mary Terry's farm; is the same as R. P. "D.," and is the top of cement filling of vitrified pipe. Elevation, 62.24.

B. M. 8: At Keene Woodyard Landing, Harrison County, Tex Is on the outside of fence line 20 meters from corner of old field; is same as R. P. "C.," and is the top of cement filling of vitrified pipe. Elevation, 61.54.

B. M. 9: At Jefferson, Marion County, Tex. Is the letter "F" in the word "Foscue" on iron door-sill northwest side of Walnut street, and the first door from corner of Fayette street; is the same as Lieut. Woodruff's bench mark, survey of 1872. Elevation, 64.70.

B. M. 10: At Jefferson, Marion County, Tex. Is star on iron doorsill, northeast side fourth door southwest of Citizen's Bank, Walnut street. Elevation, 64.54.

B. M. 11: At Jefferson, Marion County, Tex. Is cross (+) cut on south end of third step from top of east (Austin street) entrance of United States Government building. Elevation, 66.19.

Reference point "A:" At Jefferson, Marion County, Tex. Is in dooryard of property belonging to Mr. ——— Spellings, on west side of Texas street; 52 meters southeast of corner of Texas and Common streets, about 135 meters southwest of (colored) Union Baptist Church. Is the southwest point of azimuth line and is top of cement filling of vitrified pipe. Elevation, 75.9.

B. M. 12: Is across the bayou opposite Jefferson, Marion County, Tex.; in northeast corner of yard belonging to ——— Longinotti, 100 meters north of east end of iron bridge; is the same as R. P. "B.," northeast point of the azimuth line and is cross (+) cut in cement filling of vitrified pipe. Elevation, 63.48.

# Cypress Bayou Survey P. B. M.

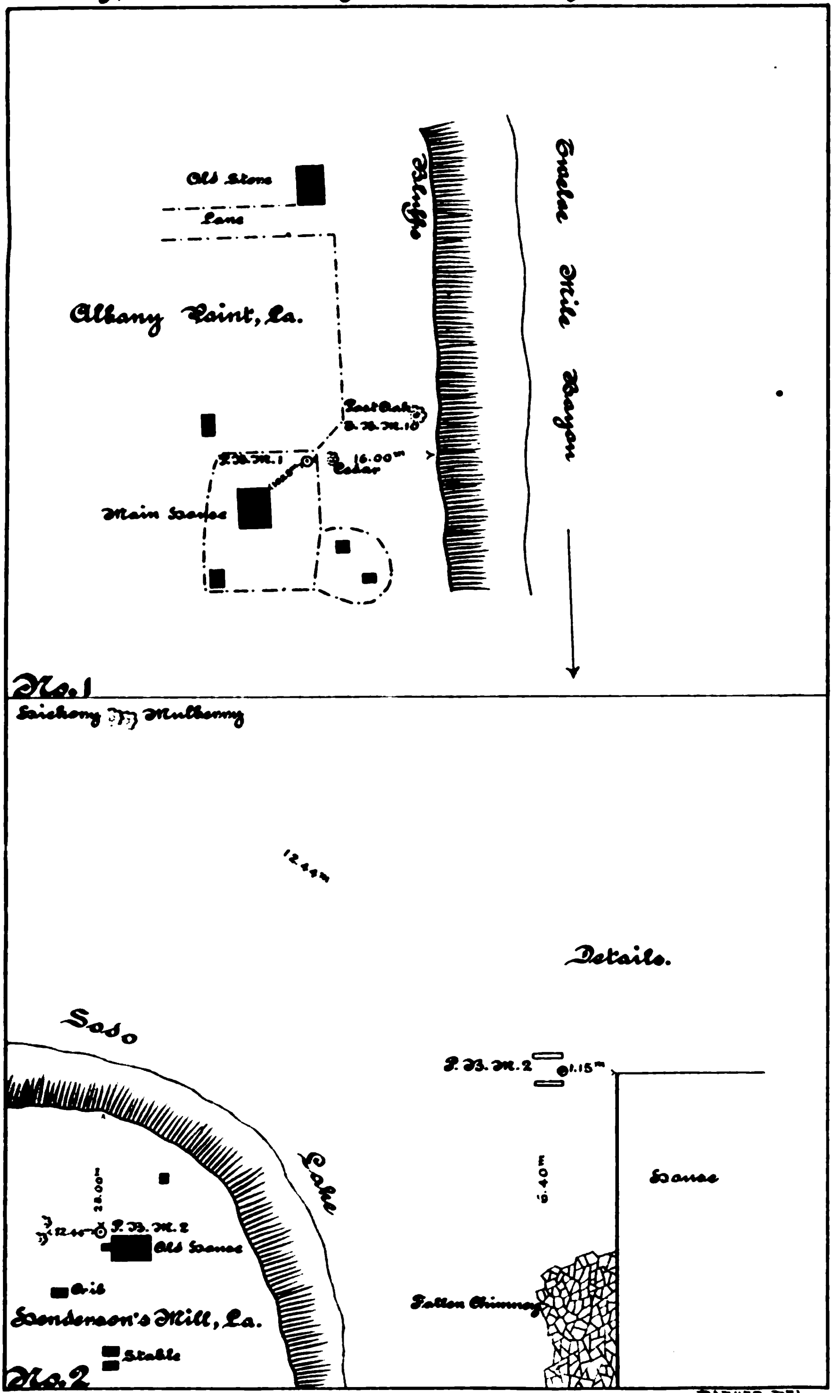

Photo-Lith. by A. Hoen & Co. Balto., Md.

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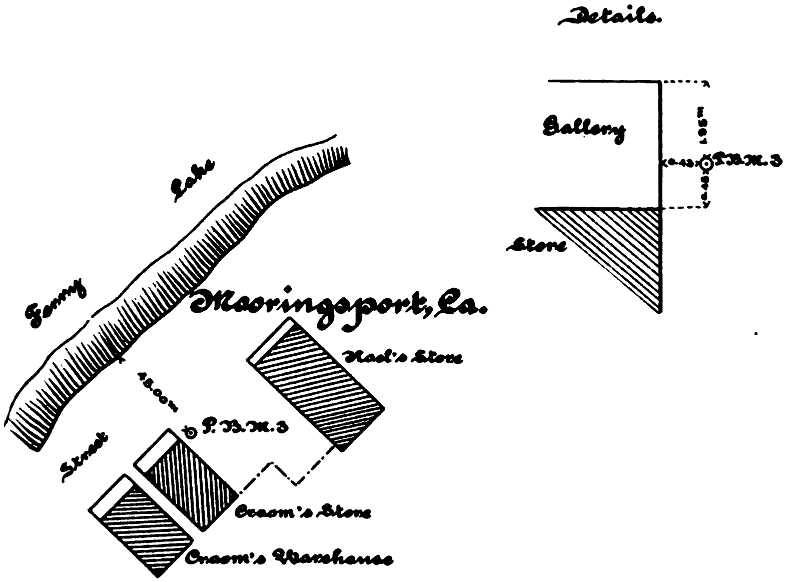
# Cypress Bayou Survey P.B.M.



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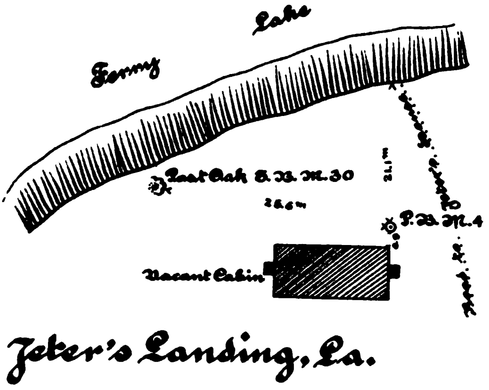

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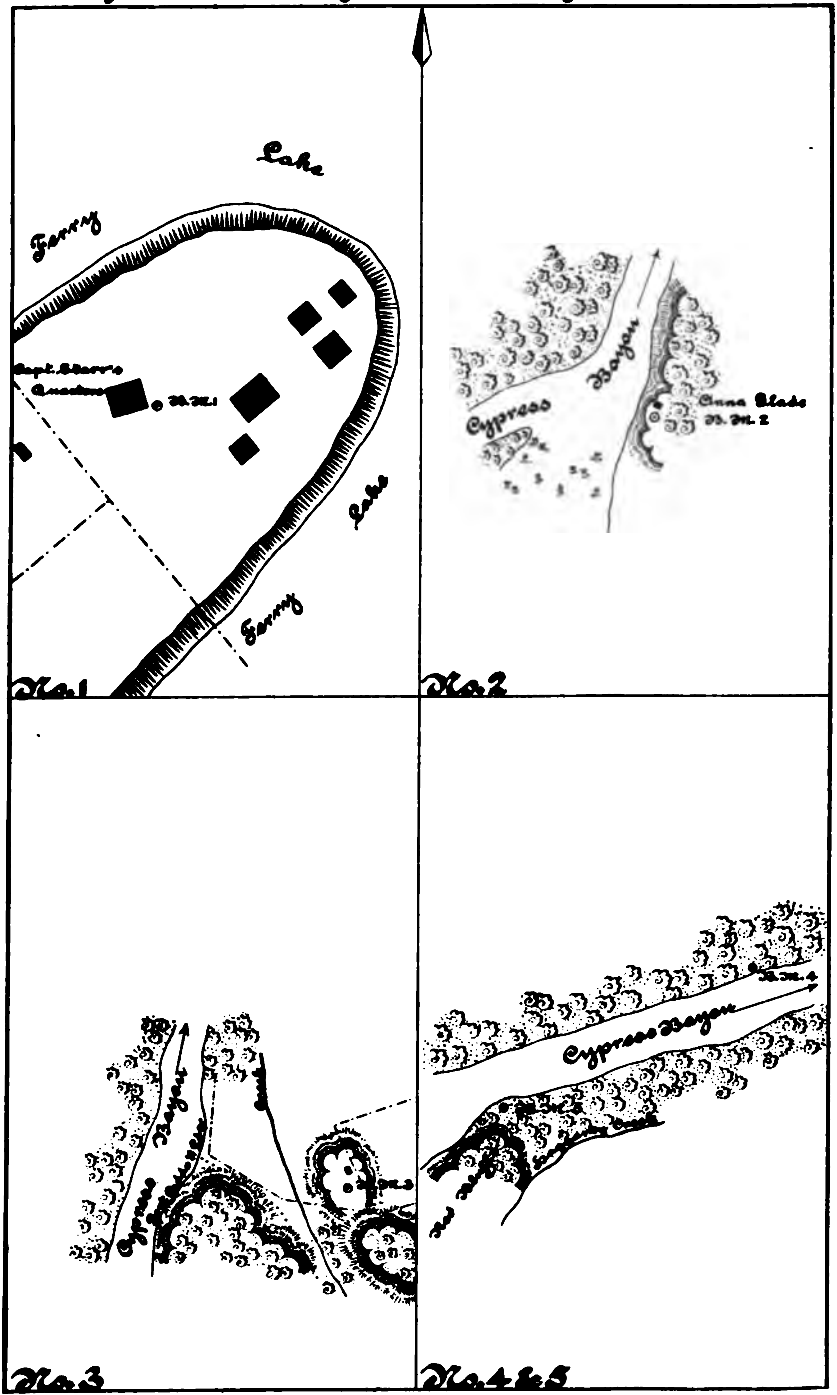

Photo-Lith. by A. Hoen & Co. Balto. Md.

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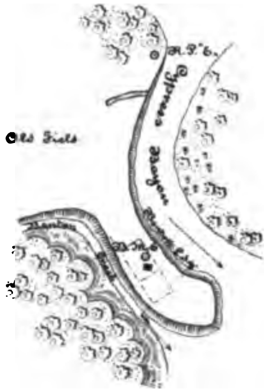
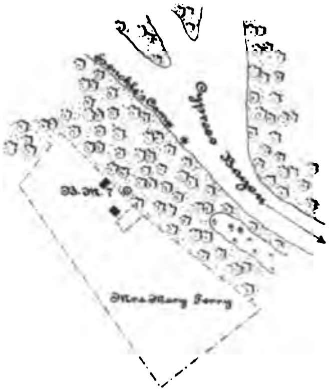
# Cypress Bayou Survey B. M.



No. 6 & R. P. "6"



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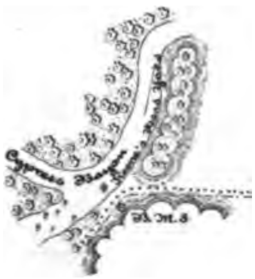

No. 8

Jefferson, Texas

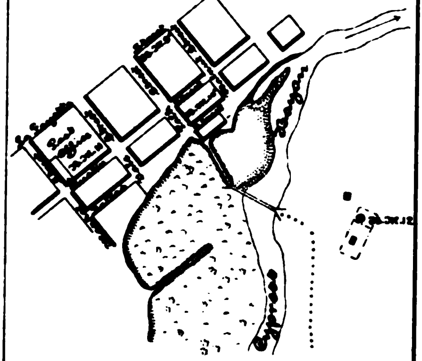

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Photo-Lith. by A. Hoen & Co. Balto. Md.

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### TABLE 5.—DESCRIPTIONS AND ELEVATIONS OF RIVER SECTION REFERENCE POINTS FROM SHREVEPORT, LA., TO ALBANY POINT, LA.

[W. H. Polk, W. V. Hall, L. Y. Kerr, topographers; Chas. H. Schermerhorn, leveler.]

[NOTE.—These reference points are placed in lines normal to bayou channel at intervals of about 8 kilometers, four reference points in each line. Any reference point is designated by the number of its line, counting from Shreveport, and by its number in the line counting from point No. 1 at outer end of line on right bank to No. 4 at outer end on left bank. Points marked by vitrified pipe set in ground and filled with cement. Elevations are in meters above Cairo datum.]

#### *Stone line No. 1.*

Stone $\frac{1}{1}$: On James Robinson's plantation, 450 meters from right bank in edge of timber, 300 meters southwest of cabin at corner of pasture. Elevation, 57.66.

Stone $\frac{1}{2}$: On James Robinson's plantation, 40 meters from right bank, 100 meters below fence line of pasture. Elevation, 59.63.

Stone $\frac{1}{3}$: On upper part of R. Q. Nicholson's plantation, 50 meters from left bank, in field about 50 meters below line of deadening. Elevation, 58.66.

Stone $\frac{1}{4}$: On upper part of R. Q. Nicholson's plantation, 350 meters from left bank and 75 meters from line of deadening. Elevation, 58.30.

#### *Stone line 2.—Cuba Plantation.*

Stone $\frac{2}{1}$: Is in the skirt of timber on left bank of "The Pass" across from upper line of Cuba Plantation. Elevation, 57.24.

Stone $\frac{2}{2}$: Is 50 meters from right bank of bayou across from upper line of Cuba Plantation, 350 meters below mouth of "Horton's Chute." Elevation, 58.68.

Stone $\frac{2}{3}$: On Cuba Plantation, 75 meters from left bank in small strip of timber between bayou and fence line, 75 meters southeast of corner of upper fence line. Elevation, 59.69.

Stone $\frac{2}{4}$: On Cuba Plantation, in field 50 meters from fence line running west from house and is 100 meters southeast of corner of field. Elevation, 60.09.

### TABLE 6.—*Sediment in Cypress Bayou and the lakes, Shreveport, La., to Jefferson, Tex.*

[Observers: T. C. Thomas and W. H. Polk.]

| Locality. | Date. | Elevation of water surface, Cairo datum. | Ratio of weight of sediment to weight of water. | | |
|---|---|---|---|---|---|
| | | | Surface. | Mid depth. | Bottom. |
| | 1891. | *Meters.* | | | |
| Shreveport, La* | | | | | |
| Cross Bayou | Mar. 2 | | 0.00015 | 0.00007 | 0.00014 |
| Twelvemile Bayou (mouth) | Feb. 21 | | 0.00015 | 0.00005 | 0.00015 |
| Do | Feb. 27 | | 0.00010 | 0.00027 | 0.00019 |
| Cuba Plantation (lower end) | Feb. 17 | | 0.00047 | 0.00045 | 0.00023 |
| Head of "cut road," Sodo Lake | Feb. 16 | | 0.00000 | 0.00025 | 0.00010 |
| Sodo Lake, Cottonwood Bayou | Feb. 16 | | 0.00000 | 0.00010 | 0.00029 |
| Near head of Big Pass | Feb. 14 | | 0.00011 | 0.00007 | 0.00015 |
| Above head of Big Pass | Feb. 11 | | 0.00022 | 0.00018 | 0.00018 |
| Do | Feb. 13 | | 0.00015 | 0.00011 | 0.00011 |
| Mooringsport, La | Feb. 10 | | 0.00006 | 0.00000 | 0.00007 |
| Do | Feb. 12 | 59.85 | 0.00000 | 0.00011 | 0.00007 |
| Jefferson, Tex | Feb. 10 | 50.73 | 0.00003 | 0.00003 | 0.00003 |
| Do | Feb. 17 | 50.06 | 0.00003 | 0.00003 | 0.00003 |
| Do | Feb. 23. | 50.18 | 0.00007 | 0.00003 | 0.00001 |

*See Table 7, Red River survey, for sediment in Red River.

**TABLE 7.**—*High-water marks on Cypress Bayou and the lakes from Jefferson, Tex., to Shreveport, La.*

| Locality. | Distance from Jefferson, Tex. | Elevation, Cairo datum. | Remarks. |
|---|---|---|---|
| **HIGH-WATER MARKS, 1868.** | | | |
| | *Kilometers.* | *Meters.* | |
| Jefferson, Tex | 0.0 | 64.62 | Authentic, June 12. |
| Smithland, Tex | 9.5 | 63.67 | |
| Port Caddo, Tex | 27.8 | 62.40 | Authentic. |
| Albany Point, La | 81.0 | 61.68 | Do. |
| Shreveport, La | 105.9 | 60.03 | Do. |
| **HIGH-WATER MARKS, 1874.** | | | |
| Albany Point, La | 81.0 | 61.17 | |
| Shreveport, La | 105.9 | 58.33 | Reading of gauge, Apr. 29-May 1. |
| **HIGH-WATER MARKS, 1882.** | | | |
| Stormy Point, La | 59.2 | 62.23 | Authentic. |
| Shreveport, La | 105.9 | 58.73 | Reading of gauge, Feb. 21. |
| **HIGH-WATER MARKS, 1890.** | | | |
| Jefferson, Tex | 0.0 | 63.26 | Authentic, Jan. 6. |
| Mooringsport, La | 60.8 | 63.13 | Authentic, May 10. |
| Shreveport, La | 105.9 | 59.73 | Reading of gauge, May 8. |
| **HIGH-WATER MARKS, 1892.** | | | |
| Mooringsport, La | 60.8 | 63.62 | Authentic. |
| Mouth of Cottonwood Bayou, Louisiana | 73.7 | 63.05 | |
| Shreveport, La | 105.9 | 60.04 | Reading of gauge, May 28. |

**TABLE 8.**—*Discharge observations in Cypress Bayou and the lakes.*

| Locality. | Date. | Areas. | Maximum mid-depth velocities. | Discharge. | Elevation of water surface, Cairo datum. | Stage below maximum high water. | Method. |
|---|---|---|---|---|---|---|---|
| | | *Square meters.* | *Meters.* | *Cubic meters.* | *Meters.* | *Meters.* | |
| Jefferson Tex | Feb. 10, 1891 | 101 | 0.76 | 58 | *60.74 | 3.1 | Mid-depth floats. |
| Do | Feb. 13, 1891 | 101 | 0.71 | 52 | *60.44 | 3.4 | Do. |
| Do | Feb. 17, 1891 | 101 | 0.44 | 32 | *60.07 | 3.1 | Do. |
| Do | Feb. 23, 1891 | 101 | 0.59 | 45 | *60.17 | 3.6 | Do. |
| Head of Big Pass | Feb. 11, 1891 | 855 | 1.03 | 625 | †59.85 | 3.8 | Current meter. |
| Do | Feb. 13, 1891 | 855 | 0.98 | 607 | †59.83 | 3.8 | Do. |
| Do | Feb. 14, 1891 | 742 | 1.00 | 526 | †59.78 | 3.8 | Do. |
| Overflow, right bank, head of Big Pass. | ....do | 279 | 0.08 | 12 | †59.78 | 3.8 | Do. |
| Albany Point, La | Dec. 26, 1890 | 218 | 1.22 | 210 | 56.93 | 6.1 | Do. |
| Twelvemile Bayou, Cuba Plantation. | Dec. 27, 1890 | 159 | 1.66 | 223 | 55.06 | 7.9 | Do. |

* Gauge read at Jefferson, Tex. † Gauge read at Mooringsport, La.

NOTE.—See Table 10, discharge observations of Red River, for Red River, outlets, Twelvemile and Cross bayous.

## V 19.

### PRELIMINARY EXAMINATION OF SULPHUR RIVER, FROM ITS MOUTH TO SULPHUR STATION, TEXAS.

UNITED STATES ENGINEER OFFICE,
*Vicksburg, Miss., May 16, 1893.*

GENERAL: In compliance with instructions contained in your letter of July 14, 1892, assigning certain localities to me for preliminary examination, directed by river and harbor act of July 13, 1892, I have the honor to submit the following report respecting Sulphur River, Texas (and Arkansas), from its mouth to Sulphur Station:

Sulphur River has its source in northeastern Texas, being formed by the North and South Forks near Hagansport, at the junction of Lamar, Delta, Hopkins, Red River, and Franklin counties. Flowing in a general easterly direction, it forms the boundary between Red River and Bowie counties on the north, and Franklin, Titus, Morris, and Cass counties on the south, crosses Miller County, Ark., and enters Red River three-fourths mile above Collins Bluff, Ark., 107¼ miles above Shreveport, La. Sulphur Station is in the southeastern corner of Bowie County, Tex., near the Arkansas line, and the river below is almost wholly in Miller County, Ark. The river below Sulphur Station was examined in 1882 by Captain (now Major) Miller, in accordance with requirements of river and harbor act of that year, and he reported that the only business done was rafting lumber; that the river was navigable at high stages for boats running in Upper Red River, but that there was not enough business to pay them to make trips into Sulphur River, and, in his judgment, that the river was not worthy of improvement, nor the work a public necessity. (Report Chief of Engineers, 1884, p. 1345.)

The report of Assistant Engineer John Ewens, who reëxamined this stream last month, is appended hereto. At present the commerce consists chiefly of rafting and towing saw logs to the mills at Sulphur Station, Tex., and Lynn, Ark. The city of Texarkana, Tex. and Ark., is only 16 miles distant by Texas and Pacific Railway from Sulphur Station, 24 miles by Texarkana and Shreveport Railroad from Linn, 8 miles by wagon road from Brown's Landing, and the projected line of the Texarkana and Fort Smith Railway probably will cross the river about 4 miles below Sulphur Station. The citizens of Texarkana are anxious to secure safe water transportation from Red River to Sulphur Station, and the resulting cheap freight rates from such competition. The work required consists of the removal of snags and logs in the channel and the cutting of overhanging timber obstructing navigation in this stretch of about 50 miles, with perhaps a small amount of dredging. * * * This work * * * it is believed will give reasonably safe navigation for all boats plying in Upper Red River for about eight months in the year. No survey is deemed necessary as a preliminary to this project.

In view of the amount of business to be benefited, the river below Sulphur Station is deemed worthy of improvement to the extent recommended above.

Very respectfully, your obedient servant,

J. H. WILLARD,
*Captain, Corps of Engineers.*

Brig. Gen. THOMAS L. CASEY,
*Chief of Engineers, U. S. A.*

(Through Col. C. B. Comstock, Corps of Engineers, Division Engineer, Southwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
SOUTHWEST DIVISION,
*New York, May 22, 1893.*

Respectfully forwarded to the Chief of Engineers.

The report of Mr. Ewens gives no information as to the present commerce on Sulphur River, below Sulphur Station, but states that there are three log booms across it. The railroad commerce of Texarkana and Queen City is given, but it appears that they are about 8 miles from the river. Apparently the interests to be benefited are the logging interest on Sulphur River.

It is stated that Sulphur River is now navigable for ten months in the year; and with some doubt I am of the opinion that this locality is worthy of improvement to a small extent, by snagging, by the General Government.

C. B. COMSTOCK,
*Colonel of Engineers, Bvt. Brig. Gen., U. S. A.,*
*Division Engineer.*

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### REPORT OF MR. JOHN EWENS, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
*Vicksburg, Miss., May 9, 1893.*

CAPTAIN: I have the honor to submit the following report of an examination of Sulphur River, Texas and Arkansas, made by me in accordance with your orders of September 12, 1892:

An unusually high and protracted stage of water in this river, the necessity of combining the work with other duties requiring my presence in the immediate vicinity, and the very small allotment available, delayed this examination until April 18. I made a preliminary visit to Sulphur River on that date, with the mayor and a committee of citizens of Texarkana, going by rail 16 miles to Sulphur Station, the upstream limit of the examination directed by the act of Congress, where Mr. J. H. Draughon, president of the Sulphur Lumber Company, provided a small steam launch for the journey. An informal inspection was made down the river about 15 miles to Blackman Point. The following day the steam launch was again placed at my disposal, and I made a careful examination over the entire river, about 50 miles, reaching Spring Bank, Ark., on Red River, the night of April 19. I returned next day in the launch as far as Lynn, Ark., a large lumber town about 8 miles above the mouth, where I procured all available data for commercial statistics, returning from that place by train to Texarkana. On the following day I accompanied the committee over the river to Lynn.

*The river.*—Sulphur River is a clear-water stream, rising in northeast Texas, in Fannin and Hunt counties. The North and South Forks form the main river near Hagansport, Franklin County. From the latter place the general course is eastward through the counties of Red River, Franklin, and Titus. Near Lydia, Red River County, the general course is southeasterly to Belden, where the general direction is east through the counties of Bowie and Cass to Sulphur Station, thence to the mouth the general course is southeasterly. From Sulphur Station downstream about 19 miles the river is very wide with no well-defined banks. As near as could be determined from interviews with parties who have practical knowledge of the matter, and from personal observations of the high-water marks on the trees, the stage at which this examination was made was about 11.0 feet, the rise and fall at Sulphur Station being about 28.0 feet. On this reach the river makes several short bends which raftsmen have shortened from time to time by cut-offs. There are some 6 or 7 of these short cuts, of no use to steamboats, but valuable for rafting timber, making the reaches much straighter. The landings on this stretch are Browns, at the State line ferry, 4 miles below Sulphur Station; Fishing Camp on left bank, and Blackman Point on right bank, 15 miles down. Browns Landing is about 8 miles from Texarkana by road, and Blackman about the same distance from Queen City on the Texas and Pacific Railway. The water width on this section of the river at the present and much lower stages is from 1 to 5 miles, and the average depth about 20 feet. The visible obstructions were dead trees, stumps, sunken logs dropped from rafts, and overhanging timber. At extreme low water obstructions of like nature, I was informed, rendered the river nearly impassable. The bed of this section is gray mud, and there was no appreciable current to be noticed through the reach.

The following little streams flow into the river in this reach: Bakers Creek, above State line; Cypress Bayou, about 300 yards below State line; Lamars Slough, and Traverse Slough, and all are pathways to fine timber lands. The fine timber lands accessible along this reach of Sulphur River are not excelled elsewhere in the South. At low water, I was informed, the bank lines are well defined through what at the existing stage appeared to be a perpetual lake with no visible bank lines for from 1 to 3 miles. Taking the river's oscillation as near as it could be determined, and the actual depths found, it is evident that there is ample depth of water even at a minimum stage for good navigation. The statements of Mr. J. H. Draughon and Mr. Wm. Buchanan, two Sulphur River pioneers, and the largest mill owners in that section, who accompanied me, agree with my own observations. The improvement of this part of the river would consist of removing the snags, sunken logs, and overhanging trees, and on closer inspection at low water it might prove to be more economical to do a little deepening through the cut-offs than to remove the obstructions in the bends they cross.

Before closing the description of this reach, it is desirable to describe the bridge at Sulphur Station. This bridge is a long trestle about 2 feet above high water, with a small movable section that can be slipped out, but the opening is barely wide enough to pass the lumber company's little tug. The Texarkana and Fort Smith Railway, now building, is expected to cross at the State line, about 4 miles below, and will have a draw sufficient to admit the largest boats now running in Red River. At the end of this reach the lake becomes a well-defined river, with bank lines perfectly marked by timber. The width is nearly uniform, and about 185 feet, with but few leaning trees or other obstructions visible at the stage when the examination was made. I was informed that at extreme low water sunken logs and snags are numerous. The banks on both sides were submerged from 5 to 10 feet, except at Lynn and Collins Bluff, opposite the mouth of McKinney Bayou. The only shoaling on this reach was just above Lynn, doubtless caused by the deposit from the sawmill at Lynn and the continuous blocking of the river by making log booms along the stretch just below this shoal. I found three of these booms on my trip down the river, and had to have them cut adrift to pass. The sawmill referred to dumps all the useless slabs and a great deal of sawdust into the river at Lynn, the detrimental effect of which can not be exaggerated.

The following little streams contribute to the waters of the Sulphur River on this reach between Blackman Point and Lynn: On the left bank Days Creek and Big Boggy Bayou; on the right bank Bayou Mercer; and between Lynn and the mouth on the left bank Cross and McKinney bayous. The latter is a stream of considerable size, and it and the smaller streams are float roads to fine timber lands adjoining.

In Sulphur River, until within 6 miles of the mouth, absolutely no current was found, but at that point a barely-perceptible inflow from Red River was observed. The inward flow from Red River has been perceptible as high as Sulphur Station, but only for very brief periods. The improvement required on this reach is of the same nature as on the reach above, viz: The removal of obstructions and a very small amount of dredging.

Summarizing the details mentioned for the reach of river commended for improvement, it will be seen that Sulphur River combines the general characteristics of a canal, lake, and river, the two former predominating; the water is clear, and only for very brief periods each season a current is manifest. Its soft, yielding bed of dark gray mud, or soft clay, suggests that perhaps it once was the deep pool of a vast swamp. The oldest and best informed steamboat and lumbermen met with informed me that Sulphur River always has been navigable for not less than ten months each year as far back as they could remember (1856). I was also informed that Sulphur River always is navigable when steamboats can come up Red River from Shreveport to its mouth.

The features that commend Sulphur River for improvement are that it is non-sediment bearing, practically without current the greater part of the time, and its bed is unchanging. The fact that all the obstructions I saw were of a primitive character shows that it bears very little drift from its source, and very little from Red River finds its way into it.

*Commerce.*—The natural and developable resources of Sulphur River fully justify the cost of the improvement that will be required. The arable lands lie half a mile or more back from the river, on high ground; there are also seemingly inexhaustible forests of oak, walnut, gum, and pine, and the nature of the river makes it tributary to all the timber and other interests of Upper Red River.

A brief synopsis of the commercial interests of two of the business centers that are practically on Sulphur River will show that it can be made useful to considerable trade that would benefit a large section of country. The first of these is Texarkana, one of the largest railroad and lumber centers of the South, 8 miles distant from Browns Landing, 44 miles above the mouth. This flourishing city has the following railroads running into it: The Texas and Pacific, Iron Mountain, St. Louis Southwestern, the Texarkana and Fort Smith, now building, to run from Kansas City to Sabine Pass, and the Texarkana and Shreveport, running from Texarkana through the lumber region 24 miles, to Lynn, on Sulphur River. A glance at the above shows that there is no rail competition at present, as the completed lines are all practically under one system. An abridged statement of the commerce of Texarkana for the year 1890, which was the only complete and accurate compilation available, will show the vast commerce to which it, and hence Sulphur River, is tributary. The railroad revenues for that year aggregated $1,687,821; of this something in excess of $1,300,000 was accredited to freights. Taking the sum of the freights as a basis, it is probable the volume of outgoing and incoming freights handled at Texarkana foot up 20,000 carloads. The railroad disbursements during the same year amounted to $923,815, and the disbursements from local industries equaled $1,372,520, or a total of $2,296,335, the principal part of which was paid to wage earners. The collective item of lumber sold—ties and bridge timber included—foots up $2,034,500; cotton handled, $229,590; and cotton-seed oil product, $210,000. The grocery sales aggregated $986,000, exclusive of meat-market sales, which reached $138,240, which, added to the groceries, shows a total of $1,124,240 to be charged to the living account of the place alone. These, with the miscellaneous items and bank transactions (estimated at $33,495,621), gave a grand total for the year of $44,660,828. Last season one produce house alone paid out over $60,000 in freights from points accessible by Sulphur River. As a lumber center Texarkana has no equal in the South, the total annual output of mills in and controlled by that city aggregating 300,000,000 feet. With river connection at Texarkana, New Orleans will again become a competitor for the business of that section. The southern staples—sugar, rice, molasses, etc.—will have in Sulphur River an economical pathway to the Northwest, while the products of that region—meats and grain—will find in it a reciprocal route to the South.

Queen City, on the Texas and Pacific Railway, is another city practically on Sulphur River, being only 7 miles from Blackman Point, the best landing on the river. The natural latent resources near Queen City and on Sulphur River are numerous and valuable, among which are the following: Coal of fair grade, lignite, and fire clay. There is a canning establishment at Queen City of 5,000 cans capacity per day, supplied from local and Sulphur River truck farms. Near Blackman Point there are reported fine deposits of pure fire clay and mineral paint, and red hematite begins to crop out at the same point. The city has recently purchased 4,000 acres of these mineral lands, and expects to have built a 100-ton furnace during the coming year. Cass County, whose products and imports are tributary to Sulphur River, has 4,000 farmers, and produces annually 30,000 bales of cotton, which, with the vast timber interest, would find its way to market by Sulphur River if improved, as there is no rail competition at present. The following are the more important commercial transactions for the past year:

*Imports.*

| | Carloads. |
|---|---|
| Flour | 51 |
| Corn | 60 |
| Hay | 18 |
| Merchandise | 109 |
| Miscellaneous | 27 |

*Exports.*

| | |
|---|---|
| Lumber | 180 |
| Shingles | 63 |
| Cotton | 320 |
| Miscellaneous | 40 |

With the completion of the blast furnace the average shipment of pig iron per month will be from 125 to 150 cars, or 1,500 to 1,800 per annum. They expect to bring the limestone for this furnace from Upper Red River. These are only a few of the many commercial interests that would be benefited by the improvement of Sulphur River.

*The improvement.*—The improvement should consist of the removal of snags, sunken logs, and stumps, and cutting away overhanging timber, and in a few places there may be required a little dredging. The deposit of sawmill waste should be stopped at once, as well as the booming of the river at any point, both of which are very injurious to the deep water of the river. In my opinion a small snag boat, say of 80 tons, well equipped with snagging apparatus and an outfit of explosives, will be the best form of plant for this work. A drag scraper to use as a dredge could be made attachable to such a boat at a very small cost. Should a snag boat not be available, a flatboat of the usual type for work of this character would accomplish the desired object, using a snag boat only for the brief time it would take to do what little dredging might be found necessary. The unusually brief periods of extreme low water in Sulphur River would make it impossible to complete the work in any one season, but by sweeping over the river at successive stages of low water enough work might be accomplished in a single season to permit steamboats to begin to utilize the river safely.

* * * * * * *

Very respectfully,

JOHN EWENS,
*Assistant Engineer.*

Capt. J. H. WILLARD,
*Corps of Engineers, U. S. A.*

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## V 20.

## PRELIMINARY EXAMINATION OF LITTLE RIVER, ARKANSAS.

UNITED STATES ENGINEER OFFICE,
*Vicksburg, Miss., May 17, 1893.*

GENERAL: I have the honor to present the following report upon the preliminary examination of Little River, Arkansas, provided for in section 6 of river and harbor act approved July 13, 1892, and assigned to me by your letter of July 14, 1892:

The amount allotted for the examinations in this district being very small and the streams assigned to me remote, I endeavored to make them in connection with other work, but was delayed in each case by unfavorable stages of water.

Assistant Engineer Ewens was ordered to make this examination last September, but was able to do so only last month. Little River had been examined by the officer in charge or by an assistant three times before this reëxamination was ordered, and each officer reported unfavorably. * * *

It is possible that a small expenditure might be of value to the United States if rock should be needed in considerable quantities for work of improvement on Red River, as it is said that stone of a grade suitable for revetment and filling dams may be obtained in the upper river, but none of the specimens confirm this statement. The country is sparsely settled and the railroads that pass through it are intended for competing lines between Texarkana, Fort Smith, and Kansas City, and will get little revenue from the intermediate country, except from timber.

The rise and fall of Red River at Fulton, about 3 miles below the mouth of Little River, is shown in the accompanying table, from which may be judged how often boats can enter Little River, and since it appears from the report of Assistant Engineer Ewens, herewith, that the only boat engaged in the trade has withdrawn for lack of business, there can be no reason for asking for an appropriation for improving the navigation of the stream.

It is my opinion, therefore, that Little River, Arkansas, is not worthy of improvement by the General Government at the present time, and that the work is not a public necessity.

Very respectfully, your obedient servant,

J. H. WILLARD,
*Captain, Corps of Engineers.*

Brig. Gen. THOMAS L. CASEY,
*Chief of Engineers, U. S. A.*

(Through Col. C. B. Comstock, Corps of Engineers, Division Engineer, Southwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
SOUTHWEST DIVISION,
*New York, May 22, 1893.*

Respectfully forwarded to the Chief of Engineers.

For reasons given by the district engineer I am of opinion that this locality is not worthy of improvement by the General Government.

C. B. COMSTOCK,
*Colonel of Engineers, Bvt. Brig. Gen., U. S. A.,*
*Division Engineer.*

*Table of gauge heights (Fulton, Ark.) corresponding to noon each day, 1892.*

[Zero of gauge, 244.78 feet above the Cairo datum plane by levels of Red River Survey.

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 6.4 | 6.6 | 11.8 | 16.4 | 23.8 | 30.4 | 14.2 | 7.4 | 9.1 | 6.5 | 15.9 | 22.5 |
| 2 | 6.8 | 6.5 | 10.1 | 14.4 | 25.9 | 31.0 | 13.2 | 7.4 | 9.7 | 6.3 | 16.0 | 21.4 |
| 3 | 8.9 | 6.3 | 9.2 | 12.6 | 26.8 | 32.2 | 12.7 | 7.4 | 9.4 | 6.2 | 18.6 | 20.0 |
| 4 | 10.4 | 6.0 | 8.4 | 11.7 | 26.8 | 32.8 | 12.2 | 7.4 | 8.4 | 6.1 | 21.2 | 18.2 |
| 5 | 9.9 | 6.0 | 8.0 | 11.3 | 26.3 | 33.0 | 12.3 | 7.4 | 8.0 | 6.0 | 22.8 | 16.0 |
| 6 | 9.0 | 6.2 | 7.8 | 13.8 | 25.6 | 33.0 | 14.0 | 7.2 | 7.6 | 5.8 | 23.0 | 13.8 |
| 7 | 8.0 | 8.8 | 7.6 | 15.8 | [illegible] | 32.6 | 14.8 | 7.0 | 7.4 | 5.7 | 23.0 | 12.6 |
| 8 | 7.9 | 11.0 | 7.8 | 18.8 | [illegible] | 32.1 | 15.4 | 6.9 | 7.8 | 5.6 | 22.2 | 12.8 |
| 9 | 7.5 | 12.6 | 8.0 | 20.2 | 27.2 | 31.4 | 14.7 | 6.8 | 7.9 | 5.5 | 20.9 | 16.0 |
| 10 | 7.1 | 12.9 | 8.1 | 20.6 | 29.1 | 30.7 | 13.9 | 6.8 | 7.6 | 5.5 | 19.6 | 21.8 |
| 11 | 6.9 | 12.6 | 7.8 | 20.8 | 30.1 | 29.8 | 12.7 | 7.7 | 7.4 | 5.4 | 18.1 | 24.0 |
| 12 | 6.4 | 12.1 | 7.5 | 20.7 | 30.8 | 28.5 | 11.8 | 8.3 | 7.4 | 5.3 | 16.6 | 24.6 |
| 13 | 6.3 | 11.4 | 7.2 | 20.2 | 31.4 | 27.0 | 11.1 | 8.2 | 10.3 | 5.3 | 16.3 | 25.2 |
| 14 | 6.0 | 10.6 | 7.1 | 19.7 | 31.7 | 25.6 | 10.9 | 7.8 | 13.5 | 5.2 | 15.7 | 27.1 |
| 15 | 5.8 | 9.8 | 7.1 | 18.8 | 32.0 | 24.2 | 11.8 | 7.5 | 14.9 | 5.6 | 14.8 | 29.0 |
| 16 | 5.4 | 9.4 | 7.5 | 17.4 | 32.3 | 22.7 | 12.1 | 7.2 | 14.4 | 5.5 | 13.5 | 29.9 |
| 17 | 5.3 | 8.9 | 8.1 | 15.8 | 32.4 | 21.0 | 12.0 | 7.1 | 18.8 | 5.4 | 12.3 | 30.2 |
| 18 | 6.0 | 8.2 | 9.0 | 13,6 | 32.8 | 18.9 | 10.9 | 7.3 | 12.0 | 5.4 | 11.3 | 30.2 |
| 19 | 9.3 | 8.6 | 10.0 | 12.0 | 33.2 | 17.0 | 10.3 | 7.5 | 10.7 | 6.7 | 10.6 | 29.9 |
| 20 | 11.7 | 11.1 | 11.4 | 10.9 | 33.6 | 15.7 | 9.6 | 7.4 | 9.6 | 7.2 | 10.1 | 29.7 |
| 21 | 12.9 | 14.0 | 12.9 | 12.6 | 33.9 | 15.0 | 9.2 | 7.3 | 8.8 | 8.5 | 9.9 | 29.5 |
| 22 | 12.8 | 17.3 | 13.8 | 16.1 | 34.6 | 14.3 | 9.0 | 7.3 | 8.6 | 8.7 | 9.8 | 29.1 |
| 23 | 12.1 | 19.6 | 15.0 | 19.6 | 34.8 | 13.8 | 8.6 | 7.1 | 9.0 | 8.4 | 9.5 | 29.0 |
| 24 | 10.9 | 20.0 | 16.1 | 20.6 | 34.8 | 14.2 | 8.4 | 7.1 | 9.0 | 11.8 | 9.0 | 28.2 |
| 25 | 9.6 | 19.8 | 17.9 | 20.4 | 34.6 | 13.8 | 8.2 | 7.0 | 8.6 | 15.6 | 8.8 | 27.0 |
| 26 | 8.7 | 19.1 | 20.7 | 19.8 | 33.8 | 13.4 | 8.0 | 7.2 | 8.0 | 19.2 | 8.8 | 25.8 |
| 27 | 8.2 | 17.5 | 22.2 | 19.0 | 33.1 | 15.2 | 7.8 | 7.8 | 7.6 | 19.4 | 14.3 | 24.4 |
| 28 | 7.9 | 16.2 | 22.3 | 18.1 | 32.5 | 16.4 | 7.7 | 8.4 | 7.2 | 18.8 | 19.5 | 22.8 |
| 29 | 7.4 | 14.1 | 21.5 | 17.5 | 31.7 | 15.8 | 7.6 | 8.4 | 6.8 | 18.6 | 22.4 | 21.2 |
| 30 | 7.2 | ....... | 20.3 | 17.7 | 30.8 | 15.0 | 7.4 | 8.5 | 6.6 | 17.7 | 22.8 | 19.5 |
| 31 | 6.9 | ....... | 18.4 | ....... | 30.4 | ....... | 7.5 | 8.9 | ....... | 16.2 | ....... | 18.7 |

REPORT OF MR. JOHN EWENS, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
*Vicksburg, Miss., April 25, 1893.*

CAPTAIN: I have the honor to submit the following report of an examination of Little River, Arkansas and Indian Territory, made in accordance with your orders of September 12, 1892:

Several attempts were made to make the examination at an earlier date, but without success, on account of the unusually protracted high stage of Upper Red and Little rivers, and owing to the limited amount available it was necessary to do the work in connection with other duties requiring my presence in that vicinity.

I left Texarkana the evening of April 10, going by rail to Wilton, Ark., the present terminus of the Texarkana and Fort Smith Railway, thence by stage to Cerro Gordo, Ark., and from that point by wagon into the Choctaw country, Indian Territory, to a point within 3 miles of the junction of the Mountain Fork with Little River, which the native Indians consider the headwaters of Little River. On account of the torrent-like character of the stream, which is a series of rapids that would make drifting downstream dangerous and going upstream impossible, the examination was made by visiting the river at such points as could be reached through the forests. At Morris Ferry, 12 miles below the State line, the rapids diminish in number and fall, and from that point the journey was continued in a skiff to the mouth, reaching Fulton, Ark., on Red River, on the 15th instant, having made a thorough examination of the river from source to mouth, interviewed every person met with, from native Choctaw Indians to planters and steamboat men at Fulton, Ark., and visited the small towns or settlements and timber and stave camps near the river.

Little River is a nearly clear mountain stream that rises in the southeastern corner of Indian Territory, formed by Gloves and Mountain forks, flows easterly until near its junction with Rolling Fork, a small tributary near the State line, where it takes a southerly course until near Little River Post-office. Thence the general direction is southeasterly to the mouth. The sources of its supply are the numerous small streams draining the counties of Little River, Sevier, Howard, and Hempstead, called Saline, Rolling Fork, and Cossotot rivers, and Caney, Mud, Flat, Johnsons, Browns, Mills, Yellow, and Hudsons creeks. In considering the question of improvement, Little River may be divided into three sections, the first of which extends from the headwaters in the Choctaw country down to Morris Ferry, a distance of about 75 miles. This part of the river, flowing in a rock and gravel bed, with frequent shoals that rise in places to heights of from 50 to 100 feet on the bank, is a mountain torrent and incapable of improvement for navigation. The second section extends from Morris Ferry to Hoods Landing, a distance of about 40 miles. At the beginning of this reach the character of the river above becomes nearly lost, the current is more gentle, with deeper water on the shoals. The river is much wider (about 200 feet) and the shoals, with but two exceptions, are not so hazardous as those found above, conditions which make navigation possible at certain stages. The oldest steamboat men and raftsmen met with informed me that, with one or two exceptions, at the lowest stages of water they have never found less than 18 inches on these shoals. The intervening pools are long and deep, and afford excellent harbors for timber rafts. There are thirteen prominent shoals on the section below Morris Ferry, viz: Yellow Bank, Rhineharts, Brittens, Stallion, Three Chutes, Dearberry Bend, Hawkins, Buffalo, Cottonwood, Miller, Hayes, Millers Bar, and Eagle Bend. While difficult to navigate at extreme low water, this reach presents no obstacles at ordinary stages. The bed is of rock and gravel, and the banks as a general thing are low and subject to overflow. The upper end of this section always has been regarded the head of navigation, but there has not been a boat to Morris Ferry in ten years. Hoods at the lower end is the only landing of importance on the reach. The third division of the river extends from Hoods Landing to the mouth, a distance of about 53 miles. On this reach there are numerous shoals that are troublesome only at extraordinary low stages, and only three of them are considered serious by river men, viz: One just below White Cliff, 10 miles below Hoods Landing; one at a point about 35 miles above the mouth, and one at Granite Bar, 27 miles above the mouth. From Granite Bar down is one continuous pool about 10 feet deep at low water. This part of Little River is the only portion that has ever had a line of boats, and is said to be navigable when boats can come up Red River to Fulton. The banks, with but few exceptions, are low and overflow yearly.

Little River is made up of pools and shoals, the latter diminishing in number and height toward the mouth. The pools are long and deep, forming a series of reservoirs that make the river respond very quickly to rains and to floods in Red River. In the latter case back-water is perceptible for a distance of nearly 50 miles above the mouth. There are no snags or other obstructions in number, or of a nature, that would justify an appropriation for their removal, even were the commerce of any notable importance, and the stream presents no features to commend it for improvement. Its shoals are essential to periods of navigation that prevail, and to remove them would destroy its present usefulness as a navigable stream. At high stages it is navigable for a long distance above the mouth, and when Red River is low no boats can reach it. I was informed by the oldest steamboat and rafts men that there is navigation for some months each year as far as Hoods Landing, which is as high as the commerce has justified making trips. The hills touch the river at Hoods Landing, White Cliff, Wildwood, Red Hills, and Shepards on this reach, and at various points above Morris Ferry to the source. The lands suitable for agriculture are all subject to overflow annually.

On the entire stretch of river traversed from the Choctaw country to the mouth I found but six habitations. None of the plantations will average in their present condition fifty bales of cotton, in fact there is not a single farm of any size on the river. Some miles back from Hood's and White Cliff there are fertile lands, the product of which has long since been diverted to the railroad. The greater population is found on the right bank, the low lands on the left bank extending too far inland for agriculture.

The latent resources are pine and oak timber, chalk, limestone, and excellent gravel. The chalk beds at White Cliff are said to be the finest in this country. Near Hoods Landing there is an immense deposit of blue marl, said to be good for fertilizing. In Sevier County it is said there are fine lead deposits.

The above comprises everything merchantable to be found on and adjacent to Little River, and can be brought to market by the river in its present condition, by taking advantage of the higher stages. It is true that for a good part of the year Little River is not easily navigable for steamboats, and the same may be said of other streams in this district that have periods each season when navigation for a few months is difficult, if not impossible, but the long and deep pools in Little River afford excellent harbors for barges while loading with rock, gravel, etc., during the low-water season. I found immense strings of timber in many of these pools awaiting a rise to float them out. Such are the prospective, latent, and active resources of this stream. As to the present needs of steamboat navigation: there has not been a boat above Hoods Landing in over ten years, and last year the only boat, an 80-ton steamer, that has been doing business in this river, withdrew on account of lack of business. In order to verify the results of my personal observations, I interviewed all interested parties on the river, resident or connected with its commerce—among them, Capt. James Crooks, the pioneer steamboat man of Little River, who has been identified with its interests for the greater part of his business career. He informed me very frankly that there was no business, either present or prospective, in Little River that would justify the Government in spending a dollar for its improvement. The only towns that might derive any benefit from water transportation are those that soon will be reached by the Texarkana and Fort Smith Railway, now building, which will cross Little River about 500 yards above Morris Ferry, running thence nearly parallel to the river to Wilton, Ark., about 8 miles from White Cliff. This road will compete with the Texas and Pacific and St. Louis and San Francisco railroads, which are reasonably accessible to the valley traversed by Little River, thus affording adequate means of transportation, and there is no obstruction to prevent the people using Little River for several months in the year should business develop to justify it.

That the subject of improving Little River has been thoroughly investigated, if not exhausted, is shown by a brief review of previous examinations: In 1879 Major Benyaurd could find no commerce that would justify any great expenditure, and reported no improvement possible except the removal of snags and leaning trees. In 1882 and 1887 Captains Handbury and Taber respectively reported that there was nothing to justify any expenditure by the General Government. The leaning trees and snags referred to by Major Benyaurd have practically disappeared, having been removed by the action of floods and by raftsmen. In conclusion it should be observed that the present natural conditions for navigation of Little River are much better than those in Red, Ouachita, and other larger streams of the district, flowing through more thickly settled and fertile valleys, whose commerce exceeds, and whose natural resources are fully equal to those on Little River. The fact that a little 80-ton stern-wheel steamboat was barely able to make a living for her owner on trips to the most thickly settled parts of the river, and with the trade drawn from the country for several miles back, as at Hoods Landing and White Cliff, is in itself sufficient to show that an expenditure for any form of improvement would be in no manner commensurate with the demands of commerce.

Very respectfully,

JOHN EWENS,
*Assistant Engineer.*

Capt. J. H. WILLARD,
*Corps of Engineers, U. S. A.*

## V 21.

### PRELIMINARY EXAMINATION OF OUACHITA RIVER, ABOVE CAMDEN, ARK.

UNITED STATES ENGINEER OFFICE,
*Vicksburg, Miss., May 17, 1893.*

GENERAL: I have the honor to submit the following report upon the preliminary examination of Ouachita River, above Camden, Ark., in compliance with the provisions of section 6 of the act of Congress approved July 13, 1892, and instructions contained in your letter of July 14, 1892:

A reconnoissance of Ouachita River from Arkadelphia to the State line was made in 1870, under direction of Lieut. Col. Raynolds, in connection with a more extended survey of Lower Ouachita River to its mouth to determine the feasibility of the permanent improvement of the river by locks and dams. An estimate * * * was submitted for removing obstructions and dredging between Arkadelphia and the State line, and Congress appropriated $25,000 March 3, 1871, for "improving Ouachita River in Arkansas." A flat boat was worked from Arkadelphia to Priors Bluff, about 15 miles above Camden, and a crane boat from Priors Bluff to State line. How much of this appropriation was expended above Camden and what benefits followed are not known. The engineer in charge did not submit estimates for continuing the work, and nothing further was done till 1883 when Maj. Miller reëxamined the river in accordance with the act of Congress of August 2, 1882, and reported the river as "not worthy of improvement, nor the work a public necessity." The act of August 5, 1886, directed a further examination of Upper Ouachita River, which I attempted to make in March, 1887, with the snag boat Wagner, but the pilot considered it unsafe to take the boat above Camden with the river, at 18 feet on the gauge, falling, although the boat drew only 26 inches. The following June, the water being very low, Assistant Engineer Coppeé made a reconnoissance by skiff from Arkadelphia to Camden, and found the river in about the same state as described in Maj. Miller's report. I recommended a single appropriation of $9,000 to cut overhanging trees and remove logs and snags, which was given in the act of August 11, 1888, "to complete the work." The river was materially improved by the work, which was done very thoroughly, but no increase of busi- was observed, and therefore no further estimates were submitted.

Assistant Engineer Ewens made an inspection of the work when near completion, and recommended closing all chutes, so as to confine the water to a single channel; but since the chief obstacle to upstream navigation consists in the excessively steep slope of the river, closing the chutes would only serve to increase the current, since the bed is not easily scoured. A complaint was made to the Secretary of War December 27, 1889, evidently under the impression that the officer in charge was expending money above Camden in his own discretion. The body of the complaint was as follows, and is given as an expression of river men:

> We, steamboat men who have been navigating this river (Ouachita) for the past thirty years, from New Orleans to Camden, Ark., beg to call your attention to the manner in which the river improvement of Ouachita has been managed. The gentleman, Capt. Davis, now in charge, informs us that his instructions are to work now on the river from Camden above. There is no steamboat business nor navigation above Camden. No boats for several years have been running there, and the money expended there is of no benefit to steamboats or commerce. The river from

Camden down is in very bad condition, as Capt. Davis knows, and requires his attention, there being very many snags and obstructions in the channel. Capt. Davis knows the best and most economical method to remove these obstructions, which should be done at once. We do not know to whom we should apply unless to you, asking you to give Capt. Davis instructions to work from Camden down. Our season for steamboating is short, and we ask as a special favor that you will refer the matter to the proper person for prompt action, and oblige us especially.

In order to get information about the business of Upper Ouachita, I directed Assistant Engineer Ewens to collect statistics, and while doing so to put up a gauge on the railroad bridge at Arkadelphia to get an approximate elevation of high and low water by railroad levels, and to obtain any further information available about the river. The following is the substance of his report:

The Ouachita is a clear stream, rising in Polk County, Ark., and flowing in a general southerly direction, assuming the proportions of a navigable river about 15 miles above Arkadelphia. From Arkadelphia to Camden the distance is variously estimated at from 75 to 90 miles. The oscillation at Arkadelphia is given as 25 feet, and at Camden high water of 1884 is said to have read 46 feet on the gauge. The average width is less than 300 feet, the slope irregular, and the bed mostly of hard clay and gravel, which the people call "concrete." The river is made up of pools of considerable depth, from 1 to 3 miles long, formed by shoals and ledges of gravel and rock, which form rapids at low stages. The river is obstructed by snags and saw logs and depleted by chutes which should be closed. I counted 496 snags and 34 sunken logs in the 28 miles below Arkadelphia, and overhanging trees in nearly all the concave bends.

Arkadelphia has a population of about 2,500, ships about 15,000 bales of cotton and some 23,000,000 feet of lumber, and is a distributing point for a considerable territory. Between Arkadelphia and the mouth of Little Missouri, about 43 miles below, there are seventeen plantations, aggrogating 9,800 acres, opened and partly cultivated, yielding about 5,000 bales of cotton annually. Near Arkadelphia are quarries of red granite, burr, and grindstone. The Iron Mountain and Southern Railroad crosses Ouachita at Arkadelphia on a fixed bridge, about 9 feet above high water, and connects with Camden by a branch from Gurdon, which has been extended to El Dorado, and will probably be continued to Monroe, and the "Cotton Belt" crosses the river on a swing bridge above Camden, which is usually regarded as the head of navigation. Freight on cotton from Arkadelphia to St. Louis or New Orleans is $2.75 the bale, while from Camden to New Orleans the charge is $1, and other freights are in proportion.

Assistant Engineer Ewens recommended an appropriation * * * to be expended chiefly in clearing the banks of leaning timber and removing logs and snags from the channel, with a small pile-driver outfit for closing chutes; and doubtless considerable good might be accomplished with such an amount in a single appropriation, but the benefits would not be lasting.

Upper Ouachita is a mountain torrent, sensitive to every shower, with short, sharp floods, and long periods of low water in time of drought. Not only is the fall very great between Arkadelphia and Camden, but the average fall varies for different sections, being very steep between the pools. The following tables of gauge readings at Arkadelphia, between October 10, 1892, and March 11, 1893, and at Camden for 1892, show the magnitude and frequency of the rises, and also indicate that the discharge at Camden is largely derived from Little Missouri, and therefore, if Congress should decide to make an appropriation for Ouachita river above Camden, the work should be limited for the present to that stretch of river. No permanent improvement can be planned until Ouachita River shall be improved by locks and dams, or otherwise, to give at least 5 feet to Camden the year round.

### *Gauge readings at Arkadelphia, Ark., between October 10, 1892, and March 11, 1893.*

**Gauge established October 10, 1892. Zero is low water, and approximately 182.569 feet above the Cairo datum plane by railroad levels from Little Rock, Ark.]**

| Day. | October. | | November. | | December. | | January. | | February. | | March. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 8 a. m. | 4 p. m. | 8 a. m. | 4 p. m. | 8 a. m. | 4 p. m. | 8 a. m. | 4 p. m. | 8 a. m. | 4 p. m. | 8 a. m. | 4 p. m. |
| 1 | ...... | ...... | 6.30 | 7.90 | 12.60 | 11.00 | 7.07 | 6.03 | ...... | ...... | 5.00 | 4.08 |
| 2 | ...... | ...... | 7.40 | 7.80 | 9.70 | 8.70 | 5.06 | 4.00 | ...... | 2.06 | 4.03 | 4.00 |
| 3 | ...... | ...... | 8.60 | 8.70 | 8.40 | 7.90 | 3.09 | 3.05 | 3.03 | 3.09 | 3.08 | 3.07 |
| 4 | ...... | ...... | 12.00 | 13.60 | 6.30 | 5.90 | 3.00 | 3.00 | 4.00 | 4.00 | 3.07 | 3.07 |
| 5 | ...... | ...... | 16.70 | 14.90 | 5.70 | 4.80 | 2.09 | 2.07 | 4.06 | 4.03 | 3.06 | 3.06 |
| 6 | ...... | ...... | 12.00 | 11.10 | 8.90 | 9.70 | 2.06 | 2.05 | 4.00 | 3.09 | 3.05 | 3.04 |
| 7 | ...... | ...... | 10.30 | 9.20 | 10.00 | 11.70 | 2.03 | 2.02 | 3.07 | 3.06 | 3.04 | 3.04 |
| 8 | ...... | ...... | 8.40 | 8.10 | 12.70 | 13.20 | ...... | ...... | 3.05 | 3.04 | 4.06 | 5.09 |
| 9 | ...... | ...... | 7.60 | 7.20 | 14.70 | 14.90 | ...... | ...... | 3.02 | 3.00 | 8.09 | 10.08 |
| 10 | 1.00 | 1.00 | 7.00 | 6.70 | 12.60 | 11.90 | ...... | ...... | 3.00 | 3.00 | 12.09 | 14.07 |
| 11 | 1.00 | 1.00 | 6.20 | 6.10 | 10.06 | 9.09 | ...... | ...... | 3.00 | 3.00 | 15.08 | 14.09 |
| 12 | 1.00 | 1.00 | 6.00 | 5.90 | 8.03 | 7.01 | ...... | ...... | 6.08 | 7.00 | ...... | ...... |
| 13 | 1.00 | 1.00 | 4.90 | 4.80 | 10.09 | 20.04 | ...... | ...... | 10.00 | 11.08 | ...... | ...... |
| 14 | 1.00 | 1.30 | 4.30 | 4.10 | 18.00 | 17.06 | ...... | ...... | 12.00 | 13.09 | ...... | ...... |
| 15 | 1.30 | 1.90 | 3.90 | 3.00 | 17.00 | 15.60 | ...... | ...... | 17.00 | 17.08 | ...... | ...... |
| 16 | 2.00 | 2.30 | 2.00 | 1.90 | 16.00 | 14.60 | ...... | ...... | 17.00 | 16.03 | ...... | ...... |
| 17 | 3.50 | 3.20 | 2.00 | 2.00 | 15.06 | 14.00 | ...... | ...... | 15.00 | 14.03 | ...... | ...... |
| 18 | 3.00 | 2.50 | 2.00 | 2.00 | 13.00 | 12.00 | ...... | ...... | 13.03 | 12.06 | ...... | ...... |
| 19 | 2.90 | 2.70 | 2.00 | 2.00 | 11.00 | 10.09 | ...... | ...... | 11.00 | 10.09 | ...... | ...... |
| 20 | 2.40 | 2.20 | 4.20 | 5.10 | 8.08 | 7.06 | ...... | ...... | 9.07 | 9.00 | ...... | ...... |
| 21 | 2.00 | 2.50 | 6.30 | 6.50 | 7.06 | 6.07 | ...... | ...... | 8.04 | 8.00 | ...... | ...... |
| 22 | 2.00 | 1.90 | 7.80 | 7.10 | 6.07 | 6.03 | ...... | ...... | 7.08 | 7.04 | ...... | ...... |
| 23 | 2.20 | 2.40 | 9.60 | 9.90 | 8.03 | 9.08 | ...... | ...... | 7.04 | 7.06 | ...... | ...... |
| 24 | 7.30 | 7.60 | 10.70 | 10.90 | 11.08 | 11.01 | ...... | ...... | 7.09 | 8.00 | ...... | ...... |
| 25 | 5.90 | 4.10 | 11.80 | 11.90 | 19.00 | 18.09 | ...... | ...... | 8.03 | 8.09 | ...... | ...... |
| 26 | 4.60 | 4.00 | 13.90 | 14.07 | 18.09 | 18.00 | ...... | ...... | 8.00 | 7.04 | ...... | ...... |
| 27 | 3.90 | 3.50 | 16.08 | 16.09 | 17.00 | 16.03 | ...... | ...... | 7.00 | 6.05 | ...... | ...... |
| 28 | 3.30 | 3.00 | 17.06 | 18.00 | 15.03 | 14.04 | ...... | ...... | 6.00 | 5.07 | ...... | ...... |
| 29 | 2.00 | 3.00 | 17.04 | 16.03 | 13.00 | 12.05 | ...... | ...... | ...... | ...... | ...... | ...... |
| 30 | 2.40 | 2.20 | 14.60 | 12.07 | 11.04 | 10.00 | ...... | ...... | ...... | ...... | ...... | ...... |
| 31 | 2.00 | 1.90 | ...... | ...... | 9.09 | 8.00 | ...... | ...... | ...... | ...... | ...... | ...... |

### *Gauge readings at Camden, Ark., for the year 1892.*

[Zero of gauge is approximately 96.69 feet above the Cairo datum plane.]

| Day. | January. | | February. | | March. | | April. | | May. | | June. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 8 a. m. | 4 p. m. | 8 a. m. | 4 p. m. | 8 a. m. | 4 p. m. | 8 a. m. | 4 p. m. | 8 a. m. | 4 p. m. | 8 a. m. | 4 p. m. |
| 1 | 19.0 | 18.0 | 13.6 | 13.3 | 20.0 | 18.5 | 24.8 | 23.7 | 25.5 | 25.7 | 20.5 | 22.0 |
| 2 | 16.3 | 16.0 | 12.5 | 12.0 | 17.5 | 17.0 | 22.4 | 21.7 | 25.9 | 26.2 | 24.7 | 26.0 |
| 3 | 17.0 | 17.9 | 11.4 | 11.0 | 15.2 | 14.7 | 20.8 | 20.6 | 26.4 | 26.3 | 28.4 | 29.5 |
| 4 | 19.2 | 19.6 | 10.4 | 10.0 | 13.8 | 13.4 | 20.6 | 20.6 | 26.0 | 25.2 | 31.8 | 33.8 |
| 5 | 20.1 | 20.2 | 9.5 | 9.3 | 12.5 | 12.2 | 20.4 | 21.0 | 23.8 | 22.8 | 36.5 | 37.0 |
| 6 | 19.6 | 18.7 | 8.8 | 8.7 | 11.4 | 11.2 | 22.5 | 23.7 | 22.0 | 21.7 | 37.1 | 36.8 |
| 7 | 17.1 | 16.2 | 9.6 | 10.6 | 11.0 | 11.3 | 26.0 | 27.1 | 21.0 | 20.2 | 36.0 | 35.4 |
| 8 | 14.6 | 13.9 | 15.5 | 18.3 | 11.7 | 11.8 | 28.6 | 29.6 | 19.5 | 19.7 | 34.5 | 33.7 |
| 9 | 12.6 | 12.0 | 21.0 | 22.1 | 11.7 | 11.5 | 30.8 | 31.4 | 22.1 | 24.2 | 32.5 | 31.7 |
| 10 | 10.8 | 10.5 | 23.4 | 24.1 | 11.0 | 10.5 | 32.5 | 33.1 | 26.3 | 27.5 | 30.3 | 29.4 |
| 11 | 10.0 | 9.8 | 24.6 | 24.9 | 10.0 | 9.7 | 34.1 | 34.6 | 28.9 | 30.0 | 27.9 | 26.8 |
| 12 | 9.5 | 9.3 | 24.6 | 24.0 | 9.2 | 9.0 | 34.9 | 34.8 | 31.5 | 32.7 | 24.6 | 23.3 |
| 13 | 9.3 | 9.3 | 22.8 | 21.8 | 8.4 | 8.3 | 34.3 | 33.9 | 34.4 | 35.3 | 21.6 | 20.2 |
| 14 | 9.4 | 9.4 | 19.0 | 18.0 | 8.0 | 8.0 | 33.2 | 32.7 | 35.6 | 35.6 | 18.5 | 17.5 |
| 15 | 9.1 | 9.0 | 16.5 | 15.8 | 7.9 | 7.9 | 31.5 | 30.9 | 34.9 | 34.2 | 16.0 | 15.4 |
| 16 | 8.7 | 8.5 | 14.8 | 14.4 | 7.9 | 8.0 | 29.7 | 29.0 | 33.5 | 33.0 | 14.4 | 13.8 |
| 17 | 8.0 | 7.9 | 14.4 | 14.2 | 8.4 | 8.7 | 27.4 | 26.6 | 32.7 | 32.8 | 12.9 | 12.4 |
| 18 | 8.0 | 8.5 | 13.5 | 13.0 | 9.0 | 9.5 | 25.4 | 24.3 | 32.8 | 33.0 | 11.5 | 11.1 |
| 19 | 10.8 | 14.4 | 12.7 | 13.4 | 10.0 | 10.8 | 22.7 | 21.8 | 33.4 | 33.9 | 10.8 | 10.7 |
| 20 | 20.0 | 22.5 | 16.0 | 19.2 | 12.0 | 13.0 | 20.3 | 19.5 | 34.9 | 35.3 | 10.7 | 10.8 |
| 21 | 25.0 | 26.0 | 23.7 | 24.9 | 14.5 | 15.9 | 19.8 | 20.8 | 35.9 | 36.0 | 11.0 | 11.0 |
| 22 | 27.0 | 27.5 | 26.7 | 27.4 | 17.9 | 19.1 | 23.4 | 24.9 | 35.9 | 35.7 | 10.6 | 10.6 |
| 23 | 28.0 | 28.1 | 28.4 | 29.0 | 21.0 | 22.2 | 26.0 | 26.6 | 35.2 | 34.9 | 10.3 | 10.1 |
| 24 | 28.1 | 28.1 | 29.7 | 30.0 | 24.3 | 25.8 | 27.2 | 27.4 | 34.2 | 33.8 | 10.0 | 9.5 |
| 25 | 27.9 | 27.4 | 30.3 | 30.2 | 27.3 | 28.3 | 27.5 | 27.2 | 33.1 | 32.6 | 9.2 | 9.0 |
| 26 | 26.7 | 25.9 | 30.0 | 29.5 | 29.3 | 29.9 | 26.9 | 26.6 | 31.7 | 31.0 | 9.1 | 9.4 |
| 27 | 24.5 | 23.5 | 28.5 | 27.5 | 30.5 | 30.7 | 26.6 | 26.0 | 29.7 | 28.8 | 10.0 | 9.8 |
| 28 | 22.0 | 20.9 | 25.7 | 24.5 | 30.9 | 30.8 | 25.6 | 25.2 | 27.5 | 26.5 | 9.3 | 9.2 |
| 29 | 19.5 | 18.5 | 23.0 | 22.0 | 30.6 | 30.1 | 25.0 | 24.6 | 24.7 | 23.8 | 9.0 | 8.6 |
| 30 | 17.0 | 16.4 | ...... | ...... | 29.5 | 28.7 | 24.7 | 25.0 | 22.5 | 21.7 | 8.0 | 8.0 |
| 31 | 15.0 | 14.5 | ...... | ...... | 27.4 | 26.4 | ...... | ...... | 20.9 | 20.5 | ...... | ...... |

*Gauge readings at Camden, Ark., for the year 1892*—Continued.

| Day. | July. | | August. | | September. | | October. | | November. | | December. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 8 a. m. | 4 p. m. | 8 a. m. | 4 p. m. | 8 a. m. | 4 p. m. | 8 a. m. | 4 p. m. | 8 a. m. | 4 p. m. | 8 a. m. | 4 p. m. |
| 1 | 7.7 | 7.5 | 5.5 | 5.9 | 10.1 | 9.1 | 4.0 | 4.0 | 7.1 | 8.0 | 30.3 | 31.0 |
| 2 | 7.2 | 7.0 | 6.4 | 6.8 | 8.1 | 7.6 | 4.0 | 4.0 | 11.5 | 15.4 | 31.6 | 31.9 |
| 3 | 6.8 | 6.7 | 7.6 | 8.0 | 7.1 | 6.8 | 3.9 | 3.9 | 19.5 | 21.0 | 31.9 | 31.6 |
| 4 | 6.5 | 6.5 | 7.8 | 7.6 | 6.3 | 6.3 | 3.8 | 3.8 | 23.0 | 23.7 | 30.7 | 30.0 |
| 5 | 6.5 | 6.5 | 7.4 | 7.1 | 6.2 | 6.1 | 3.8 | 3.8 | 24.8 | 25.5 | 29.0 | 28.1 |
| 6 | 6.5 | 7.0 | 6.6 | 6.2 | 6.0 | 5.8 | 3.8 | 3.8 | 26.5 | 27.0 | 26.4 | 25.3 |
| 7 | 8.7 | 9.2 | 5.8 | 5.7 | 5.7 | 5.5 | 3.7 | 3.7 | 27.8 | 28.0 | 24.0 | 23.0 |
| 8 | 8.9 | 8.5 | 5.5 | 5.4 | 5.4 | 5.3 | 3.7 | 3.7 | 28.0 | 27.9 | 22.3 | 22.7 |
| 9 | 8.0 | 7.7 | 5.3 | 5.2 | 5.3 | 5.3 | 3.6 | 3.6 | 27.0 | 26.1 | 24.5 | 24.8 |
| 10 | 7.6 | 8.0 | 5.2 | 5.2 | 5.2 | 5.2 | 3.6 | 3.6 | 25.0 | 23.0 | 26.0 | 26.7 |
| 11 | 8.9 | 9.5 | 5.4 | 5.5 | 5.5 | 5.7 | 3.6 | 3.6 | 21.2 | 20.5 | 27.5 | 27.7 |
| 12 | 10.0 | 10.0 | 5.6 | 5.6 | 6.0 | 6.4 | 3.5 | 3.5 | 19.5 | 18.8 | 27.9 | 28.0 |
| 13 | 10.1 | 10.4 | 5.6 | 5.4 | 6.5 | 7.4 | 3.5 | 3.5 | 18.0 | 17.6 | 28.5 | 29.2 |
| 14 | 10.0 | 9.7 | 5.5 | 5.7 | 9.1 | 9.3 | 3.5 | 3.5 | 17.0 | 16.8 | 31.0 | 31.7 |
| 15 | 9.2 | 8.8 | 6.1 | 6.0 | 9.3 | 9.1 | 3.8 | 4.0 | 16.0 | 15.6 | 33.0 | 31.0 |
| 16 | 8.4 | 8.0 | 5.6 | 5.5 | 8.4 | 8.8 | 4.3 | 4.8 | 15.0 | 14.8 | 36.2 | 37.2 |
| 17 | 8.0 | 8.3 | 5.2 | 5.1 | 8.7 | 8.2 | 5.4 | 6.1 | 14.5 | 14.2 | 38.0 | 38.0 |
| 18 | 9.7 | 11.7 | 5.1 | 4.9 | 7.5 | 7.1 | 6.4 | 7.0 | 13.5 | 13.1 | 37.8 | 37.5 |
| 19 | 12.1 | 11.8 | 4.8 | 4.7 | 6.5 | 6.3 | 7.5 | 7.5 | 12.6 | 12.8 | 37.0 | 37.0 |
| 20 | 11.0 | 10.3 | 4.6 | 4.5 | 6.0 | 5.8 | 7.0 | 6.7 | 12.8 | 12.8 | 36.9 | 36.6 |
| 21 | 9.1 | 8.5 | 4.5 | 4.4 | 5.5 | 5.4 | 6.2 | 6.0 | 12.8 | 12.8 | 36.2 | 36.1 |
| 22 | 7.7 | 7.2 | 4.3 | 4.3 | 5.2 | 5.1 | 5.7 | 5.5 | 12.6 | 12.5 | 35.5 | 35.3 |
| 23 | 6.8 | 6.5 | 4.3 | 4.9 | 5.0 | 4.9 | 5.4 | 5.4 | 12.5 | 12.5 | 35.0 | 34.8 |
| 24 | 6.5 | 6.5 | 6.1 | 7.2 | 4.8 | 4.8 | 5.3 | 5.3 | 12.8 | 12.9 | 34.5 | 34.2 |
| 25 | 6.4 | 6.3 | 7.8 | 7.9 | 4.7 | 4.7 | 8.0 | 11.1 | 12.6 | 12.3 | 33.8 | 33.5 |
| 26 | 5.9 | 5.7 | 8.2 | 8.5 | 4.6 | 4.5 | 12.8 | 12.3 | 11.8 | 11.8 | 33.0 | 32.5 |
| 27 | 5.5 | 5.3 | 8.9 | 9.5 | 4.4 | 4.4 | 10.5 | 9.6 | 13.5 | 15.5 | 31.9 | 31.3 |
| 28 | 5.2 | 5.1 | 12.1 | 13.2 | 4.3 | 4.2 | 8.4 | 8.0 | 20.0 | 22.0 | 30.4 | 29.7 |
| 29 | 5.1 | 5.0 | 14.6 | 15.0 | 4.2 | 4.2 | 7.4 | 7.0 | 25.0 | 26.2 | 28.6 | 28.0 |
| 30 | 5.0 | 5.1 | 14.6 | 14.1 | 4.1 | 4.1 | 6.6 | 6.4 | 28.0 | 28.9 | 26.6 | 26.0 |
| 31 | 5.2 | 5.3 | 12.8 | 11.5 | ...... | ...... | 6.6 | 6.2 | ...... | ...... | 24.5 | 24.0 |

The zeros of the gauges have been referred to the Cairo datum approximately, with a probable error of 3 or 4 feet, by the following methods: The coast survey precise bench at Little Rock was connected with the rail at Baring Cross bridge and the railroad levels accepted thence to the bridge at Arkadelphia, where a gauge was set up and connected with high-water marks reported by citizens of that place. The reconnoissance levels of 1871 from Camden to Monroe were connected with precise levels from the Coast Survey bench opposite Vicksburg through a bench supposed to be a common bench of the Ouachita levels of 1871 and 1874. The zeros of both gauges were set at lowest water, so far as could be ascertained, and from such approximate information the following table has been made:

| | Arkadelphia. | Camden. | Fall. |
|---|---|---|---|
| | *Feet.* | *Feet.* | *Feet.* |
| Zero and low water | 182.569 | 96.69 | L. W ...... 85.879 |
| High water, 1884 (reported gauge) | 24.957 | 46.00 | |
| | 207.526 | 142.69 | H. W ...... 64.836 |
| Zero and low water | 182.569 | 96.69 | |
| High water, May, 1892 (gauge record) | 21.555 | 36.00 | |
| | 204.124 | 132.69 | H. W ...... 71.434 |
| Zero and low water | 182.569 | 96.69 | |
| Gauge December 17, 1892 | 14.530 | 38.00 | |
| | 197.099 | 134.69 | *62.409 |

* Difference at noon December 17, 1892.

From this table it will be seen that dredging the bars would serve only to drain the pools, unless prosecuted on so large a scale as to reduce the total fall at low stages to about 60 feet. But should lower Ouachita ever be improved by locks and dams the system might be extended upstream, although an enormous amount of dredging still would be required.

The low-water discharge at Camden is only about 10 cubic meters, say 350 cubic feet per second, and at Monroe 800 cubic feet. Flood discharges have not been measured at either place, but last May two days were spent in measuring discharge at Monroe when the gauge read 37.8 feet above zero, or about 12 feet below highest water, and the discharge computed to be 56,000 cubic feet per second, or seventy times the low-water discharge. The section at highest water would be not less than 10,000 square feet greater than that measured when the observations were made and, therefore, it is perfectly safe to estimate the flood discharge of this river at any section at over one hundred times that at extreme low water.

From the foregoing, and because I have been unable in any way to obtain trustworthy reports of the business done, I am of the opinion that Ouachita River above Camden is not worthy of further improvement by the General Government at the present time and that the work is not a public necessity. The reports on former examinations will be found in the reports of the Chief of Engineers, 1871, p. 340; 1884, p. 1351; and 1887, p. 1495.

Very respectfully, your obedient servant,

J. H. WILLARD,
*Captain, Corps of Engineers.*

Brig. Gen. THOMAS L. CASEY,
*Chief of Engineers, U. S. A.*

(Through Col. C. B. Comstock, Corps of Engineers, Division Engineer, Southwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
SOUTHWEST DIVISION,
*New York, May 22, 1893.*

Respectfully forwarded to the Chief of Engineers.

For reasons stated by the district engineer I am of the opinion that this locality is not worthy of improvement by the General Government.

C. B. COMSTOCK,
*Colonel of Engineers, Bvt. Brig. Gen., U. S. A.,*
*Division Engineer.*

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## V 22.

## PRELIMINARY EXAMINATION OF CASSITY BAYOU, MISSISSIPPI.

UNITED STATES ENGINEER OFFICE,
*Vicksburg, Miss., May 17, 1893.*

GENERAL: In compliance with instructions contained in your letter of July 14, 1892, assigning certain localities to me for preliminary examination, directed by river and harbor act of July 13, 1892, I have the honor to submit the following report upon Cassidys Bayou, Mississippi:

This stream derives its name from an old raftsman, and properly should be designated Cassity Bayou. It lies between Coldwater and

Tallahatchee rivers on the east and Big Sunflower River on the west, and has its source in Moores Bayou, Quitman County, about 8 miles west of Belen, the point where Moores Bayou enters Coldwater River. Following a tortuous course, in a general direction a little east of south, through parts of Quitman, Coahoma, and Tallahatchie counties, the bayou enters Tallahatchee River one-half mile below Sharkey Landing, the highest point on that river to which boats make regular trips throughout the year. The length of the bayou is estimated to be about 80 miles.

Under river and harbor act of July 5, 1884, Cassity Bayou was examined by Capt. Bergland, who reported that the improvement above the mouth of Hopson Bayou was not worthy of consideration * * * and that in his opinion the small amount of commerce to be benefited was not commensurate to the cost of the work. (Report Chief of Engineers, 1885, pp. 1534–1537.)

Under river and harbor act of August 5, 1886, a reëxamination was made by me, and I reported that the bayou was cleared in 1860 by the planters interested at a cost of about $5,000 * * * and that in my opinion the stream was as worthy of improvemement as any of the high-water tributaries in the district. (Report Chief of Engineers, 1887, p. 1497.)

By an act of the legislature of the State of Mississippi, approved March 18, 1886, copy of which is inclosed herewith, a charter was granted the Cassity Lock and Dam Company, giving the exclusive right to improve and navigate Cassity Bayou for thirty years. The existence of this law was unknown to me when my report upon the reëxamination was made in 1887, and as soon as it was learned report of the matter was made to the Department May 3, 1888, as the river and harbor bill then before Congress contained an item appropriating $2,500 for improving Cassity Bayou, which was omitted from the act as passed.

At present there is no commerce in the bayou beyond the rafting of saw logs, and an occasional flatboat propelled with poles. In former years it was navigated at high stages by very small steamboats, but the accumulation of obstructions caused the number of trips to decrease gradually until they ceased altogether. The amount of cotton raised annually along the 50 miles for which improvement has been recommended is about 2,500 bales, which, with about 1,000 tons of seed and return freights of supplies and a considerable traffic in timber and staves which has developed of late years, constitute the commerce to be benefited at present. If the bayou were opened to navigation it is estimated that it would result in an annual saving of about $2,000 to the planting and timber interests along the stream, which are without railroad facilities. The danger of overflow has been decreased greatly since 1884 by the effective levee system along the Mississippi front, and as the soil is rich it is probable that if an economical means of transportation were assured the country would be settled more rapidly.

In view of the foregoing it is not deemed necessary to make a further examination or survey of the stream, and in my opinion the bayou is worthy of improvement by the General Government to the extent recommended in my report of 1887, viz: * * * to remove the snags, logs, drift, leaning timber, etc., obstructing navigation of the lower 50 miles, to permit navigation of small steamboats during high stages, or for about six months of the year.

It is suggested, however, that appropriation for this purpose should not be made until the charter granted by the Mississippi legislature is revoked, or, if made, that it should contain a clause prohibiting any expenditure until such action is taken. Section 7 of the State law referred to provides that the charter is subject to forfeiture upon the failure of the corporation to commence work within five years from the date of the act. I am unable to learn that any work has been done by the company, but as the chopping of a tree or removal of a snag might be considered the commencement of work, this suggestion is offered.

Very respectfully, your obedient servant,

J. H. WILLARD,
*Captain, Corps of Engineers.*

Brig. Gen. THOMAS L. CASEY,
*Chief of Engineers, U. S. A.*

(Through Col. C. B. Comstock, Corps of Engineers, Division Engineer.)

[First indorsement.]

U. S. ENGINEER OFFICE,
SOUTHWEST DIVISION,
*New York, May 22, 1893.*

Respectfully forwarded to the Chief of Engineers.

In view of the small amount of commerce stated by the district engineer to exist, I do not deem this locality at present worthy of improvement by the General Government.

C. B. COMSTOCK,
*Colonel of Engineers, Bvt. Brig. Gen., U. S. A.,*
*Division Engineer.*

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Chapter CCCCIV.—An act to incorporate the Cassity Lock and Dam Company, of Tallahatchie County and for other purposes.

SECTION 1. *Be it enacted by the legislature of the State of Mississippi,* That E. F. Gibbs, W. H. Fitzgerald, Geo. S. Irving, J. Mell Smith, E. G. Payne, and J. W. Sharbrough, and such persons as may hereafter become associated with them, be, and they are hereby, constituted a body politic and corporate, under the name and style of the Cassity Lock and Dam Company, and as such may sue and be sued, plead and be impleaded in all the courts of law and equity of this State; may have a common seal and alter the same at pleasure, may make by-laws, hold real and personal property, and do any and all acts which corporate bodies may do, not inconsistent with the laws of this State.

SEC. 2. *Be it further enacted,* That the capital stock shall be five thousand dollars, which may be increased from time to time at the pleasure of the stockholders, and whenever the sum of twenty-five hundred dollars has been subscribed, and thirty per cent thereof paid in, the company may commence business, and the stockholders shall be individually liable for the debts of the company to the amount which may be unpaid on the stock subscribed for by each of them respectively, and no further; the shares of the stock shall be of such denomination as the stockholders may from time to time designate.

SEC. 3. *Be it further enacted,* That the officers of the said corporation shall consist of one president, one vice-president, one secretary, and one treasurer, but the last two named offices may be held by the same person, and which officers, with two other persons, to be chosen by the stockholders, shall constitute a board of directors for the management of the affairs and business of said company, and who shall have such powers as may be conferred upon them by the stockholders. The persons herein named as incorporators shall constitute the first board of directors, from whom the officers shall by them be elected, to hold for one year, and until their successors are elected and qualified. No failure to elect officers or directors at the time named shall work a forfeiture of this charter, and in such case an election may be held at any time fixed by the stockholders; any vacancy in the board of directors shall be filled by the remaining members of the board.

SEC. 4. *Be it further enacted,* That the said corporation is hereby empowered and authorized to remove all obstructions from and deepen and widen the channel of Cassity, Opossum, and Hobson bayous, in the counties of Tallahatchie, Quitman, and

Coahoma, to cut and remove timber, logs, trees, and other obstructions on the banks or in the beds of said bayous, which in any way interfere with the navigation thereof, to build and construct all necessary locks and dams, so as to make said streams or any portions thereof suitable and fit for the purposes of navigation by steamboats or other water crafts, and in consideration of the time, labor, and money expended by the said company in improving the said streams as aforesaid, said corporation shall have the sole and exclusive right to use and navigate the said streams, or such parts thereof as they may improve, for the period of thirty years, and to charge reasonable tolls or freights for all persons or property transported by them, and to navigate the said streams with such water crafts as they may see proper to use.

SEC. 5. *Be it further enacted*, That the said streams are hereby declared to be navigable streams, and the said corporation to be a common carrier; and the said corporation may contract with the owner of any land, timber, earth, or material, or any article whatever, which may be wanted by it in clearing out the said streams, removing obstructions, navigating the same, or for any purpose connected with the business for which this charter is granted; and in case of any disagreement with the owner as to the price or value of any land, or inability to procure the same by contract with the owner, or if the owner is under any disability in law to contract, or is out of the county, application may be made to the clerk of the circuit court of the county where such owner resides, or where such lands or articles may be, who shall thereupon immediately issue a writ of *ad quod damnum*, under the seal of the circuit court, commanding the sheriff of said county to summons a jury of twelve disinterested citizens of the county to appear at or near the land to be valued, on a day to be named in said writ, not less than five nor more than thirty days after the issuing of the same; and if any of the persons summoned do not heed, the sheriff shall forthwith summons as many as may be necessary to furnish a panel of twelve jurors, who shall be a jury of inquest of damages, and after an oath or affirmation administered to each by the sheriff, justly and impartially to value the damages which the owner shall sustain by the use, or occupation, or appropriation of land sought to be taken or acquired by the said corporation, the jury shall ascertain and fix the amount of such damages, and shall reduce their inquisition and verdict to writing, and sign the same; and when the value so found by the jury shall be paid or tendered to the owner of the property, or his legal representatives, or other persons legally authorized to receive the same, the said corporation shall be entitled to the land so valued, as fully as if conveyed by the owner, for such time as the said corporation shall use or occupy the same for the purposes or uses granted by this charter; and the inquest of the jury, after the payment or tender of payment of the value so fixed, shall be admitted to record in the office of the circuit clerk of the proper county, and shall be a bar to all actions for taking or using said property; and the said sheriffs and jurors shall be entitled to recover from said corporation such fees as are allowed by law for like services in the circuit court: *Provided*, That either party may, within ten days, appeal from the decision of the said jury to the circuit court of the proper county in which said property is situated; and said court shall proceed thereon as in case of an appeal from the board of supervisors in relation to public roads: *And provided further*, That before the issuance of the said writ of *ad quod damnum* the corporation, by some of its officers, shall make and file with the circuit clerk an affidavit setting out the residence and post-office address of the persons supposed to be the owners of the property sought to be acquired by the corporation; or if such residence and post-office are unknown, said affidavit shall so state, and that the corporation has been unable to ascertain the same after making diligent inquiry, and as to all supposed owners residing in the county, the sheriff shall serve upon them a copy of the said writ personally, or by leaving the same in the possession of some person residing at or near the property sought to be acquired, and the clerk shall mail a copy thereof, by registered letter if possible, to the owner, in all cases addressed to their post-office, if known to him, and if such clerk is unable to secure a receipt for such registered letter in a reasonable time, then he shall cause publication to be made for such land-owner as now required for non-resident defendants in chancery suits; such supposed owners with copies of the said writ, as herein directed, shall not invalidate any of the proceedings aforesaid.

SEC. 6. *Be it further enacted*, That books of subscription to the capital stock of said corporation may be opened, and said corporation organized wherever the persons herein named as corporators may determine to do so.

SEC. 7. *Be it further enacted*, That this charter is subject to forfeiture upon the failure of said corporation within five years from the date of its approval to commence the necessary work to carry out the objects of this charter in making said streams navigable as aforesaid.

SEC. 8. *Be it further enacted*, That this act take effect and be in force from and after its passage.

Approved, March 18, 1886.

## V 23.

## PRELIMINARY EXAMINATION OF COLDWATER RIVER, MISSISSIPPI.

UNITED STATES ENGINEER OFFICE,
*Vicksburg, Miss., May 17, 1893.*

**GENERAL:** I have the honor to present the following report upon the preliminary examination of Coldwater River, Mississippi, provided for in section 6 of the river and harbor act approved July 13, 1892, and assigned to me by your letter of July 14:

The reports of former examinations and of the work done on this stream will be found in the Reports of the Chief of Engineers, 1879, p. 984; 1880, p. 1321: 1881, p. 1413; 1882, p. 1551; 1883, p. 1149; 1884, p. 1336; and 1885, p. 1518. * * *

Owing to the small amount allotted for examinations in this district, I decided to have this stream reëxamined in connection with other work, but it has happened that whenever it was convenient to send an assistant for the purpose the stage of water has been too great to permit him to see the obstructions. The snag boat *Meigs* was sent into Tallahatchee River in April, but after two weeks' work above Sharkey, ordinarily considered the head of navigation of that river, the excessive spring rains filled the upper river and overflowed Tallahatchee so that the boat had to be withdrawn.

Coldwater River has its source in Marshall County, northern Mississippi, near Holly Springs, and, following an irregular course, flows in a general southwesterly direction to Yazoo Pass, an outlet which formerly connected it with Mississippi River about 5 miles below Helena, Ark., but closed by the line of levee since 1871, which greatly reduced the amount of water supply. Below Yazoo Pass it flows in a southeasterly direction to its junction with Little Tallahatchee River in Quitman County, a distance of about 40 miles. It was examined first by Maj. Benyaurd in 1879, who submitted an estimate * * * for removing raft and other obstructions below Yazoo Pass to its junction with Tallahatchee River. Congress appropriated $7,000 in 1879 and $4,000 in 1880, but after two seasons work it was reported:

> The work done below Sharkey has given satisfaction to the steamboat men, but the work done above that point they state is of no benefit to them; they request me to respectfully recommend to you that any future work on the Tallahatchee should be done below Sharkey Landing, and that it consist of the removal of snags from the channel by a light-draft snag boat in the low-water season. (1880, p. 1323.)

Sharkey Landing is about 40 miles below the junction of Coldwater and Little Tallahatchee rivers, a stretch of river through a wild and thinly-settled country, subject to overflow. In succeeding reports it was recommended that no further appropriation should be made for Coldwater, as no business had been developed.

The project adopted in 1879 for improving Tallahatchee River contemplated removing the obstructions below mouth of Coldwater to Yazoo River in two consecutive seasons of low water at a cost of $40,000, but the total amount appropriated for that work in fourteen years is $32,500, the greater portion of which has been expended for the removal of obstructions below Sharkey Landing. By acts of 1880, 1881, and 1882, $10,000 were required to be expended for the improvement of Little Tallahatchee River, above mouth of Coldwater to Batesville, but the work resulted in no benefit to navigation or commerce. It is my opinion, therefore, that until the original project for improving Tallahatchee River to the mouth of Coldwater shall be completed, the question of extending the improvement up the Coldwater and Little Tallahatchee should not be considered, as however much might be expended on those streams, no benefit would be gained, because Tallahatchee for 40 miles below still remains unimproved and closed to steamboat traffic at ordinary stages that permit boats to reach Sharkey Landing, 240 miles from Mississippi River.

Since the closing of Yazoo Front, the railroad, now the Yazoo and Mississippi Valley division of the Illinois Central, has been extending along the tributaries, and one branch runs from Clarksdale down the higher ground west of Coldwater and Tallahatchee to Minter City on the latter, where an incline has been built for transfer of river freights; Minter City being considered the safe limit for navigation at ordinary and lower stages. The business of Upper Tallahatchee, Coldwater, and Cassity Bayou consists almost entirely of getting out rafting timber and staves, but it is next to impossible to obtain trustworthy statements of its value. At the highest estimate the value of the log rafts and staves sent downstream from Coldwater does not exceed $30,000 a year, and since a considerable amount will have to be spent upon Tallahatchee River between Sharkey Landing and the mouth of Coldwater before the improvement of the latter would give any returns, I am of the opinion that Coldwater River, Mississippi, is not worthy of improvement by the General Government at the present time.

Very respectfully, your obedient servant,

J. H. WILLARD,
*Captain Corps of Engineers.*

Brig. Gen. THOMAS L. CASEY,
*Chief of Engineers, U. S. A.*

(Through Col. C. B. Comstock, Corps of Engineers, Division Engineer, Southwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE, SOUTHWEST DIVISION,
*New York, May 23, 1893.*

Respectfully forwarded to the Chief of Engineers.

For the reasons stated by the district engineer I am of opinion that this locality is not worthy of improvement by the General Government.

C. B. COMSTOCK,
*Colonel of Engineers, Bvt. Brig. Gen., U. S. A.,*
*Division Engineer.*

# APPENDIX W.

## IMPROVEMENT OF ARKANSAS RIVER AND OF CERTAIN RIVERS IN ARKANSAS AND MISSOURI.

### *REPORT OF CAPT. H. S. TABER, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1893, WITH OTHER DOCUMENTS RELATING TO THE WORKS.*

**IMPROVEMENTS.**

1. Removing obstructions in Arkansas River.
2. Arkansas River.
3. Fourche Le Fevre River, Arkansas.
4. Petit Jean River, Arkansas.
5. White River, Arkansas.
6. Cache River, Arkansas.
7. Little Red River, Arkansas.
8. Black River, Arkansas and Missouri.
9. Black River, Missouri.
10. St. Francis River, Arkansas.
11. St. Francis River, Missouri.
12. Little River, Missouri.
13. Removing sunken vessels or craft obstructing or endangering navigation.

**EXAMINATIONS.**

14. Saline River, Arkansas.
15. Fourche Le Fevre River, Arkansas.
16. Current River, Arkansas.

UNITED STATES ENGINEER OFFICE,
*Little Rock, Ark., July 1, 1893.*

GENERAL: I have the honor to transmit herewith the annual reports for the fiscal year ending June 30, 1893, upon the works under my charge.

I am, sir, very respectfully, your obedient servant,

H. S. TABER,
*Captain of Engineers.*

Brig. Gen. THOMAS L. CASEY,
*Chief of Engineers, U. S. A.*

## W 1.

## REMOVING OBSTRUCTIONS IN ARKANSAS RIVER.

As the first expenditure of money on this river was made as early as 1833, it is not an easy matter to determine what was the original condition of the navigable portion of this stream, but from the delta-like character of its lower portion and the tendencies now manifest in its upper reaches, it may be inferred upon very substantial grounds that shifting sand bars, numerous drift piles, and dangerous snags characterized the obstacles to navigation in the lower reaches, and gravel and rock shoals, with a few snags and many overhanging trees, constituted those of the upper reaches. The records of this office indicate that, except at a few places, such as Pine Bluff, Ark., and Fort Smith, Ark., the general plan of improvement has consisted of snagging operations, which include cutting overhanging trees and in building wing dams to improve the shoals, the idea being to afford temporary relief to navigation until complete surveys should render it possible to project a plan for the radical and permanent improvement of the navigable portion of the entire river. For the exceptions noted, attention is respectfully invited to reports upon these special cases.

The appropriations have been made sometimes for the entire navigable reach and sometimes for certain sections.

The grand total of all these appropriations up to June 30, 1892, amount to $505,251.37. Of this there had been expended up to June 30, 1892, $410,946.10, exclusive of certain sums aggregating over $100,000 that were appropriated with the Mississippi and Missouri rivers, so as not readily to be determined.

The most permanent result of all this expenditure consists in a series of maps made by S. T. Abert from a survey of the river from Fort Gibson, Ind. T., to Big Rock, Ark., 3 miles above Little Rock, Ark., in the year 1870, and also another series of maps from Wichita, Kans., to Fort Gibson, Ind. T., from a survey in 1884. From the nature of the case the balance of the work has been each year a repetition of that of preceding years. One iron-hulled snag boat and one light-draft snag boat (wooden), with all the appliances necessary for snagging operations, were the visible signs of the balance, while the gratitude of those interested in the navigation of the river for a navigation rendered yearly less and less dangerous by the operations of these two boats, is the only evidence existing, and the only evidence to be expected, of work that must be done in a stream like this, until by some system of permanence caving banks no longer exist and the annual quota of snags is no longer furnished.

The most economical management of snag boats requires not less than $35,000 annually to give absolutely indispensable aid to navigation, a navigation in which a vast amount of commerce is vitally interested.

During the fiscal year ending June 30, 1893, $22,073.54 was expended in the snagging operations of the United States snag boats *Wichita* and *Pioneer* and the running expenses of the two boats.

The *Wichita* took the field July 18, 1892, and continued operations until September 25, 1892, removing 619 snags and destroying 7 drift piles.

The *Wichita* being required on towboat service in more important work elsewhere the snag boat *Pioneer* was put in the field October 1, 1892, and continued operations until December 10, 1892, at which time the boat was wrecked. During this period 243 snags were removed, 10 drift piles destroyed, and 670 overhanging trees cut.

A portion of this time the river was too high for effective snagging operations.

Proper authority, under date of July 26, 1892, having been received for the sale of the tow boat *C. B. Reese* from this appropriation to the appropriation "improving Arkansas River, Arkansas," the funds from that sale are now being used for the construction of a new snag boat for this appropriation.

For commerce, see report for improving Arkansas River, Arkansas.

*Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $2,028.43 |
| Received on account of sale of United States towboat *C. B. Reese* | 20,000.00 |
| Amount appropriated by act approved July 13, 1892 | 20,000.00 |
| | 42,028.43 |
| June 30, 1893, amount expended during fiscal year | 22,073.54 |
| July 1, 1893, balance unexpended | 19,954.89 |
| July 1, 1893, outstanding liabilities | 4,322.58 |
| July 1, 1893, balance available | 15,632.31 |
| Amount (estimated) required for completion of existing project annually | 35,000.00 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895 | 70,000.00 |
| Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893. | |

*Expense account.*

| | | | |
|---|---|---|---|
| Pay roll | $9,973.22 | Medicine | $45.15 |
| Subsistence | 1,338.62 | Sale of United States snag boat *Missouri* | 3,000.00 |
| General supplies | 2,712.75 | Sale of United States snag boat *Pioneer* | 3,500.00 |
| Lumber | 791.90 | Reserved in United States Treasury for freight charges | 6.32 |
| Fuel | 285.40 | Grand total | 22,073.54 |
| Traveling expenses | 29.70 | | |
| Stationery | 154.43 | | |
| Rent | 205.00 | | |
| Telephone rent | 25.00 | | |
| Transportation | 6.05 | | |

## W 2.

### IMPROVEMENT OF ARKANSAS RIVER.

Work during the past season has been carried on under four different acts of Congress. By act approved August 5, 1886, $75,000 was appropriated under this head, its distribution being indicated in the following words and figures:

> Improving the Arkansas River, Arkansas: Continuing improvement, according to the plans and recommendations in Appendix V, 13, Ex. Doc. No. 1, Forty-ninth Congress, of which there are to be expended $8,000 at Pine Bluff; $13,000 at Fort Smith, and $10,000 at Dardanelle, or so much thereof under these sums, respectively, as may be necessary at these points.

All of this money, except a small sum out of the $10,000 for Dardanelle, having been expended prior to June 30, 1890, it is only necessary to summarize the project for Dardanelle, as follows: At Dardanelle the $10,000 is to be expended in erecting a permeable dike above and opposite the town, in such a position as to remove the sand bar now in front of the wharves.

By act, which became a law August 11, 1888, $150,000 were appropriated under this head, its distribution being indicated in the following words and figures:

> Improving Arkansas River, Arkansas: Continuing improvement, $150,000: *Provided*, That nothing herein contained shall authorize the Secretary of War to enter upon project of improvement of said river as set forth in the Report of the Board of Engineers on improvement of Arkansas River, from Wichita, Kans., to its mouth, dated New York City, March 16, 1888, and contained in House Ex. Doc., No. 234, Fiftieth Congress, first session: *Provided*, That the Secretary of War shall expend the appropriation under this head with reference to the final improvement of this river as contemplated in the Report of the Chief of Engineers for the year ending June 30, 1885, and as authorized in the act for the improvement of rivers and harbors, approved August 5, 1886, and in House Ex. Doc., No. 90, Forty-ninth Congress, first session, said methods to be applied as the Secretary of War may direct at such points between Wichita, Kans., and the navigable mouth of the Arkansas River at its junction with the Mississippi River, as he may deem for the best interests of commerce. And all moneys now to the credit of different sections of the Arkansas River, other than the appropriations for the operating of the snag boats, shall be available for use under this head; and in future the engineer in charge of this work and the Secretary of War shall make report upon the progress and needs of this work under this head instead of reporting upon disconnected projects as heretofore. Nothing herein contained shall be understood to prevent the Secretary of War from applying any part or all funds previously appropriated for use at Fort Smith, Dardanelle, in Pine Bluff Reach, or from expending not exceeding $8,000 as a contingent fund for expenditure in Pine Bluff Reach.

By act approved September 19, 1890, $180,000 were appropriated, its distribution being indicated as follows:

> Improving Arkansas River, Arkansas: Continuing improvement from Wichita, Kans., to its mouth, $180,000.

The approved projects for the expenditure of this sum may be summarized as follows:

At Van Buren the $4,000 to be expended in erecting a permeable dike at a suitable point a little above the town and upon the opposite side of the river, to contract the channel and prevent it from leaving the city wharves.

From Fort Gibson, Ind. T., to the mouth of the river, the balance to be expended in the erection of permeable dikes, and in one instance by rock excavation at the worst places, or the places at which serious interference with the largest amount of commerce occurs, so far as the amount of the appropriation will permit, looking toward the permanent improvement of the river, to give a channel at least 6 feet deep and 200 feet wide from Little Rock to the mouth of the river, via White River Cut-Off, as provided under the act of August 5, 1886, and an all-year-round depth of water of at least 2 feet from Little Rock, Ark., to Fort Gibson, Ind. T., under all acts, the work to be carried on by hired labor and the purchase of material in open market, as this is believed to be most economical and advantageous to the Government.

Before operations were begun at Dardanelle, a bad bar had formed along the town front, cutting off all approach to either wharf at low water or at medium stage.

From Fort Gibson to the mouth of the river, the river consists of alternating bars and caving banks, with crossings more or less troublesome at low water, a few of the latter operating to effectually close the river to navigation at extreme low water for even boats drawing but 2 feet of water. In all cases of this kind the crossings occur at points at which, while the river is falling from a 10-foot stage to extreme low water, its water is so widely spread that it developes no channel at any point.

Seven years of careful study of this river, combined with the testimony of the navigators of the river, all point to this fact, that the crossings are deep or shallow in proportion as the water is narrow or broad at or above the crossing, and that a very slight contraction, such as that produced by a few logs, tree tops, and sometimes clay lumps, just sufficient to give defining power to the current, will convert a bad crossing into a good one.

By act approved July 13, 1892, $250,000 were appropriated, its distribution being indicated as follows:

> Two-fifths of this amount shall be expended from the mouth of the river to Little Rock, two-fifths from Little Rock to Fort Smith, and one-fifth above Fort Smith.

The approved projects for the expenditure of this sum may be summarized as follows. The one-fifth above Fort Smith will be applied to render permanent the works already put in between Fort Smith and a point 30 miles above, by conversion of six filled hurdle dikes into solid stone-capped dikes.

This done, the next shoal reach above will be taken up, surveyed, and a special project submitted and work done, and then the next reach, and so on as far as the funds will permit.

The two-fifths between Fort Smith and Little Rock will be applied in the same manner, first to solidifying existing works in the reach just above the Baring Cross Bridge and at Dardanelle, and then the reach next above Little Rock, near Rectors Chute and the reach some 40 miles below Fort Smith, after careful surveys and under special projects in each case, making finished work both up from Little Rock and down from Moores Rocks as far as the funds will permit.

The two-fifths between Little Rock and the mouth to be applied in the same way to the solidifying, under proper projects and careful surveys, of the existing works upon the experimental reach just below the Little Rock and Fort Smith Railway Bridge at Little Rock, and also in the Pine Bluff and Rob Roy Reach, and then taking up the next bad reach below each of the two reaches, under special projects after careful surveys, working simultaneously below the cities of Pine Bluff and Little Rock, completing the works as far as the funds will permit.

The wording of the appropriation make the division of the work mandatory. The method of applying it being based upon the fact that the two bridges at Little Rock give fixation to the head of the work at that point and the works at Pine Bluff do the same for the reach below.

Between Little Rock and Fort Smith it is possible to hold the works at almost any point, by virtue of ledges of rock and gravel bars, and the same is true of the river above Fort Smith.

The plan adopted for these reaches effect the greatest amount of commerce and renders this effect as promptly as possible with the limited funds.

Extensive additions to the plant will also be required, which will also be made the subject of special correspondence.

Under all acts, the work to be carried on by hired labor and the purchase of material in open market, as this is believed to be the most economical and advantageous to the Government.

Acting upon this plan, during the fiscal year ending June 30, 1893, $177,897.98 have been expended, viz: Dikes Nos. 1½, 2, 2½ and 3 above Fort Smith were converted into solid stone-capped dikes.

At Van Buren, Ark., about 7 miles below Fort Smith, the old dike at this point was solidified and the old railway incline in the same vicinity, and about 900 feet long, was converted into a solid stone-capped dike.

The work at Moores Rocks, about 30 miles below Fort Smith, consisted originally of the cutting of a channel 75 feet by 425 feet, with a depth of 2 feet below low-water mark through a rock reef, was completed by the excavation of 1,055 cubic yards of rock.

During the fiscal year ending June 30, 1892, 926 cubic yards had been excavated, which with 270 cubic yards excavated during the fiscal year ending June 30, 1891, and the 1,055 cubic yards excavated during the fiscal year ending June 30, 1893, makes a total of 2,251 cubic yards of rock excavated on this work.

At Dardanelle, Ark., the fleet was put in position late in the month of May, 1893, and operations commenced at that point by the opening of a stone quarry and the collection of material for the solidifying of the old dike and the construction of a new solid stone-capped dike 250 feet in length in the same vicinity.

At Big Rock quarry, 3 miles above Little Rock, 12,215 cubic yards of rock have been quarried, and of this amount 3,500 cubic yards have been barged to Pine Bluff.

Above Little Rock and the Baring Cross Bridge at that point Dikes A, B, and C were converted into solid stone-capped dikes, and two additional solid stone dikes, A$^1$ and D, in the same vicinity, each 150 feet long and 7 feet above low water, were constructed.

Dikes Nos. 1, 2, 3, and 4 upon the experimental reach, just below the Little Rock and Fort Smith Railway Bridge at Little Rock, were also converted into solid stone dikes.

At Pine Bluff, Dikes Nos. 2, 3, and 4 were converted into solid stone-capped dikes, the bank between Dikes 4 and 5 revetted, and the revetment of the bank between Dikes 5 and 6 begun.

Dikes A$^0$ and A, below Pine Bluff in the Pine Bluff and Rob Roy Reach, are now being solidified.

It was proposed, besides the solidifying of these dikes, to revet the bank opposite in the expenditure of the balance available for this reach, but the recent high water has thrown a bar along the bank it was proposed to revet, which will be 8 or 10 feet above low water, while Dike 5 has been severely punished, and there is danger of the river cutting back of Dike 6. The policy adopted to hold all that has been gained, and the danger being more imminent from Dikes 5 and 6 than to the bank opposite Dikes A$^0$ and A, and, as before stated, this work is now in progress of construction.

Special surveys were made in the vicinity of Fort Smith, Van Buren, Dardanelle, Little Rock, and Pine Bluff.

In addition to the above work, twenty barges, 60 by 20 feet, one pile-driver barge, 74 by 20 feet, equipped as a water pile-driver, and one quarter boat, 90 by 20 feet, have been built, besides various additions to the machinery and buildings of the plant, as well as a large amount of repairing. An additional pile-driver barge is now in course of construction.

Nothing but a condensed summary of the results of the work can be given within the limits of this report.

The channel at Moores Rocks is a perfect success.

As to all the rest of the work it may be stated briefly that they give abundant evidence that the plan adopted will be efficient. This was shown graphically last year, and as the works have passed beyond the tentative period it is not thought necessary to reproduce the report of last year. The low dikes when judiciously located and carefully completed in the proper numbers, do as contraction work, cause the river to attack the bottom and produce the results aimed at as set forth in the original plan.

The works in the Pine Bluff Reach have been subjected to a very severe test and prove that dikes can be so constructed as to remain intact under the most vigorous attacks of this rapid rising river. With this question settled, and the results given last year as the outcome of contraction works, it is plain that when these works are properly located and completed in proper numbers and made solid, the plan is effective. As to the work proposed it may be said that this is already a matter of printed record, based upon regular plans and estimates, which are supplemented for each reach of the river by special projects prepared under special surveys prior to entering upon the work. The policy pursued now is to fix upon points or reaches that can probably be entirely completed with the amount appropriated and finish them rather than to do a little work here and there, which shall form at best only a part of the work that should be done at these points.

It is a matter of plain duty to insist that prompt and appreciable results can not be expected with $250,000 when $1,000,000 is required, and as matters now stand if anything like effective work, with economy, is expected at least $1,500,000 could be profitably expended during the year ending June 30, 1895.

With small sums the engineer spends more time in the vain effort trying to make both ends meet than in actual engineering study or development of the works. Fully $100,000 ought to be expended in the plant at once. There are not barges, pile-drivers, and steamboats enough to do economical work. Again, material and labor is advancing very rapidly in price, and it will cost one-third more to do the work on this account. It will be noted that there is quite a sum available. This results from a desire to use the largest sum possible in actual construction work rather than in plant. It will be exhausted very soon.

By building plant, four times the amount could have been advantageously used. In connection with this river I must again respectfully invite attention to the wonderful development of this State and the natural tendency of all this to make Little Rock a great commercial center. All the statistics connected with my reports bear upon this more or less. As one reach of the river under consideration has Little Rock at its head, the great importance of these works becomes more apparent. A careful study of statistics for six years convinces me that the State of Arkansas will ere long rise many files in the rank of the States, and public improvements will return manifold their costs in material benefit to the entire State. The amount stated above as being required to complete the improvement only refers to the reach from Fort Gibson to the mouth: If the improvement is to be extended from Arkansas City, Kans., to the mouth of the river, there must be added for the reach from Arkansas City, Kans., to Fort Gibson, Ind. T., $1,696,900.

## COMMERCE.

No new data has been secured in regard to commerce since last report.

| | | |
|---|---|---|
| Tonnage | tons | 717,202 |

### *Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $37,459.69 |
| Amount appropriated by act approved July 13, 1892 | 250,000.00 |
| | 287,459.69 |
| June 30, 1893, amount expended during fiscal year | 177.897.93 |
| July 1, 1893, balance unexpended | 109,561.76 |
| July 1, 1893, outstanding liabilities | 15,176.55 |
| July 1, 1893, balance available | 94,385.21 |
| Amount (estimated) required for completion of existing project | 3,222,479.00 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895 | 1,500,000.00 |
| Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893. | |

### *Expense account.*

| | |
|---|---|
| Pay roll | $96,043.41 |
| General supplies | 15,476.86 |
| Subsistence | 16,425.95 |
| Lumber | 5,902.40 |
| Fuel | 5,855.37 |
| Traveling expenses | 822.74 |
| Stationery | 373.02 |
| Transportation | 294.82 |
| Rent | 335.00 |
| Telephone rent | 47.17 |
| Land rent | 50.00 |
| Water rent | 8.50 |
| Medicine | 104.71 |
| Piling, brush, and poles | 4,171.00 |
| Stone and rock | 10,506.07 |
| Flags | 16.95 |
| Anchor | 35.85 |
| Skiffs and oars | 272.64 |
| Deposited to credit of United States Treasury for freight charges | 134.98 |
| Sale of United States towboat *C. B. Reese* | 20,000.00 |
| Reserved in United States Treasury for freight charges | 1,020.49 |
| Grand total | 177,897.93 |

## W 3.

## IMPROVEMENT OF FOURCHE LE FEVRE RIVER, ARKANSAS.

The improvement of this stream was begun in 1879 under the act approved March 3, 1879. Prior to any improvement, its channel was choked with snags, logs, and drifts and heavy timber overhung its banks. Several bad shoals also impeded navigation.

Up to June 30, 1886, $21,000 had been expended in removing the greater part of the obstructions, though the shoals and now and then a snag that had washed in since work was suspended in December, 1882, still offered serious obstacles to navigation at medium stages of water. By act approved August 6, 1886, $5,000 were appropriated for removing rock shoals, situated about 4 miles below Perryville. At the close of the fiscal year ending June 30, 1888, this sum had been expended, completing a channel about 500 yards long, 30 feet wide, and 2 feet deep at low water through this shoal. From June 30, 1888, to September 19, 1890, no appropriations were made for this work. By act approved September 19, 1890, $7,500 were appropriated. The approved project for its expenditure provides for the building and equipping of a hand-propelled snag boat of the *A. B. Johnson* model at a cost not to exceed $4,000; that it be operated for four months, if possible and necessary, at or near extreme low water, in removing accumulated obstructions in the way of snags, logs and drift piles, and also landslides and certain bowlders on Piney Shoals, and $450 to be expended in making a square section through May Shoals in the place of the present reversed arch, which will not permit a square-bowed flatboat to pass, and take out a portion of a rock at Red Ferry, which lies like a whale's back and offers a very narrow channel to steamboats. All this to provide for high and medium-stage navigation; low-water navigation is out ot the question, except, say, for 26 miles from its mouth to Piney Shoals.

During the fiscal year ending June 30, 1891, $2,448.70 was expended in building a hand-propelled, light-draft snag boat after the *A. B. Johnson* model; this boat is to be operated only at or near exteme low water. During the year no such water occurred. During the month of August, 1891, the water having reached a proper stage, the snag boat was thoroughly equipped with crew and supplies and sent to the field of operations.

The whale-back rock at Red Ferry was removed to the depth of 5 feet by taking out 90 cubic yards of rock. The square section through May Shoals was completed by the removal of 373 cubic yards of rock and gravel. Piney Shoals was cleared of obstructions by the removal of 61 snags, 31 logs, and 50 cubic yards of rock, cutting 825 overhanging trees and deadening 34. The total work of the season consists of the removal of 1,326 snags and stumps, 4 large drift piles, 923 cubic yards of rock and gravel, several landslides, cutting 15,559 overhanging trees and deadening 1,185, thus giving the river a high and medium-stage navigation from the mouth to Perryville Landing, a distance of about 30 miles.

During the fiscal year ending June 30, 1892, $3,743.33 was expended for the above work and care of property and records. Most careful attention was given to the operations of the boat, and I am happy to state she has sustained the record heretofore made by this class of snag boats. The present appropriation practically meets all the demands of commerce upon the river. It is probable that after awhile additional snagging operations may be required and certain improvements made through the shoals as this valley settles up and the increased commerce warrants the same.

During fiscal year ending June 30, 1893, no attempt was made to do any work, as the accumulation of snags was not sufficiently great to warrant getting the boat to work. The property was cared for and eventually the boat was sold to the appropriation, "Removing Obstructions in the Arkansas River, Arkansas and Kansas," thus giving an additional sum available for the further operations upon this river as required.

By judiciously watching conditions, this money may be made to keep this river in good condition for many years to come.

## COMMERCE.

No new data has been secured in regard to commerce since last report, though diligent efforts have been made to do so.

*Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $1,307.97 |
| Received on account of sale of United States snag boat *Pioneer* | 3,500.00 |
| | 4,807.97 |
| June 30, 1893, amount expended during fiscal year | 316.47 |
| July 1, 1893, balance unexpended | 4,491.50 |

*Expense account.*

| | |
|---|---|
| Pay roll | $250.00 |
| General supplies | 25.97 |
| Stationery | .50 |
| Rent | 40.00 |
| Grand total | 316.47 |

## W 4.

### IMPROVEMENT OF PETIT JEAN RIVER, ARKANSAS.

Before improvement this river was obstructed with snags, logs, drift piles, overhanging trees and shoals. The original project for improvement contemplated rendering it navigable during high and medium stages of water as high as Danville, Ark., by cutting the overhanging trees and cutting up the snags, logs and drift. The fall in the river is so great that nothing could be done to improve the shoals. The first appropriation ever made for the river was that of the act approved August 5, 1886, amounting to $3,500, one half the estimate, $7,000. This amount was expended prior to June 30, 1888, in completing the work of improvement to Rocky Crossing, or about one half the distance.

The act which became a law August 11, 1888, appropriated $2,500 and provides for continuing the improvement below the Iron Bridge at Rocky Crossing. It will be seen that this is a departure from the original project and contemplates entering upon an improvement of a semipermanent character. This reach of river was accordingly visited in person and a new project prepared and duly approved. This project provided that $2,500 be expended below Rocky Crossing in removing timber from the low-water channel and in removing a small portion of the ledges at Slaty Crossing and Robinsons Ridge, so as to prolong the season of navigation. After many delays, fully explained in reports of former years, the work under the latter project was completed during the fiscal year ending June 30, 1891.

The advantages given commerce by these improvements have been fully set forth in former reports.

By act approved July 13, 1892, $3,500 were appropriated.

During fiscal year ending June 30, 1893, only $7.50 were expended.

This river has but little plant of its own and no regular snag boat, always depending upon idle plant upon other rivers. May and June are the months in which the water is at suitable stage for work.

Plan for work proposed the use of the snag boat *Pioneer*, which belonged to the appropriation "Improving Fourche Le Fevre River, Arkansas."

Last December, while employed upon the Arkansas River, Arkansas, this boat was wrecked. Another boat of the same kind was bought from the appropriation "Improving St. Francis River, Missouri," and during the May and June rises of the Mississippi and St. Francis rivers, the boat was brought over the Sunk Lands and taken down near the mouth of the St. Francis River, by about the middle of June. It was expected to send a steamboat after her to bring her around into the Arkansas River and thence into the Petit Jean River, but just at this critical time two steamboats were disabled, and the fiscal year closed without the boat being able to reach the work. No particular loss has accrued to the interests of navigation, however, as the bridge at Rocky Crossing, reported as an obstruction, remains intact, and until this is removed, the work to be done will not be available to steamboats.

During the coming year this work will be completed, when the stage of water is suitable. The present appropriation meets the present demands of commerce.

### COMMERCE.

There has been no new data received in regard to commerce since last report.

| | | |
|---|---|---|
| Tonnage | tons.. | 1,600 |

### *Money statement.*

| | |
|---|---|
| Amount appropriated by act approved July 13, 1892 | $3,500.00 |
| June 30, 1893, amount expended during fiscal year | 7.50 |
| July 1, 1893, balance unexpended | 3,492.50 |

### *Expense account.*

| | |
|---|---|
| Record books | $7.50 |

## W 5.

### IMPROVEMENT OF WHITE RIVER, ARKANSAS.

Prior to improvement this river was much choked with snags, drift piles, and logs in its lower portion, and from Batesville up, gravel bars, rocky shoals, channel bowlders and overhanging trees impeded navigation. The originally adopted project consisted in snagging operations, blasting of ledges and bowlders, and dam building to remove gravel bars, or to close chutes from time to time as appropriation warranted and commerce required. The first separate appropriation for this river was made by act approved July 5, 1884. At the time it was passed the river was in excellent navigable condition for boats drawing not to exceed 3 feet of water, from its mouth to Newport, Ark. From Newport to Batesville there were many troublesome snags, and from Batesville to Buffalo Shoals there were numerous bad shoals, rendering navigation very uncertain. From Buffalo Shoals to Forsyth, Mo., there were many fine reaches of river, but the depth of water on Buffalo Shoals and others less dangerous prevented any navigation at ordinary stages of water. This river has been united so often with the St. Francis, and again, once with the Black and Little Red, that it is impossible to give exactly how much had been expended upon the White River to June 30, 1884.

After a careful study of House Ex. Doc., No. 64, Forty-eighth Congress, first session, the approximate amount is set down as not under $170,000 and not over $200,000.* This estimate should be given a weight of 8 in a scale of 10. The project for expending the appropriations made by acts of July 5, 1884, August 5, 1886, and August 11, 1888, provided for the removal of snags, bowlders, and other obstructions to navigation, building wing dams to improve shoals, repairs to and care of plant, and survey of river, as provided for in the acts, with a view to its permanent improvement from Forsyth, Mo., to its mouth.

Up to June 30, 1892, $108,708.04 had been expended. This completed the survey, plotted the notes, published the maps, and effectually improved some of the most dangerous shoals between Buffalo Shoals and

Newport, Ark.; gave much relief to navigation by removing the most dangerous snags from Batesville to the mouth of the river, constructed and equipped six barges, one floating pile driver, cared for the property, and partly completed a dike at Newport, and improved the following shoals:

Cornwall Shoals, Cato Shoals, Saffold Shoals, Hagglestooth Shoals, Cleghorn Shoals, Rock Boat Shoals and Black Island Shoals, building 1,900 feet of dams, requiring for their construction 2,844 cubic yards of rock, and 510 cords of brush. Dike A, at Newport, was completed; Dike B, just below Newport, to the extent of building and weighting 306 feet of mattress, and driving a few piles.

During the fiscal year ending June 30, 1893, $26,284.10 were expended.

With the exception of repairs and increase to plant, no active operations were commenced until February, 1893, when surveys were made at and in the vicinity of Little Island, about 30 miles from the mouth of the river.

In March, a base of supplies was established at Devall's Bluff, Ark., and a stone quarry was opened at Bee Rock, on little Red River, quarters built for the accommodation of the working force, and the fleet which had formerly been stationed at Newport, Ark., was transferred to Bee Rock, and a portion sent to St. Charles, on White River, in the vicinity of the first dikes to be built.

There has been quarried at Bee Rock 4,200 cubic yards of rock, and 2,924 cubic yards barged to the location of the new dikes. High water has prevented the continuation of the surveys, and also the commencement of the actual construction of the dikes, though no loss of time has been sustained in this direction, as advantage was taken of the extreme high water to accumulate material at the work. The plant was thoroughly overhauled and equipped and put in good working condition, four new barges having been constructed, and others remodeled.

As soon as the water subsides, the surveys will be completed, projects drawn for the worst reaches, beginning at the mouth of the river, and construction work begun according to the plans fully set forth in former reports. Repairs will also be made to works upon the shoals in the Upper River, and the new hull for the towboat *Henry Sheldon* will be completed. These repairs and this construction are to be made out of the sum that was to be expended at the direction of the Secretary of War.

The appropriation made by act approved July 13, 1892, reads as follows:

> Improving White River, Arkansas: Continuing improvement, $75,000, $53,815 of which shall be used for completion of the existing project, the remainder to be expended in the discretion of the Secretary of War.

The advance of each season makes it more and more apparent that the vast commerce of the territory drained by this river would, before many years, demand a lock and dam system. The great commercial interests due to the inexhaustible mineral resources of the territory which are concentrating upon the improvement of this river are becoming more clamorous for an improved highway, and the possibilities of this river are scarce second to any in the district.

It is very important that my annual report for the year 1891 should be carefully considered, yet I do not think that I am warranted in going over all the ground carefully gone over in that report. I will simply say that the time is coming when a system of locks and dams will be required in the upper river; and it is my duty to renew the recommendation made last year in regard to preliminary surveys in connection with the work.

I must again respectfully invite attention to the increase in the tonnage of the river, and to my statement made in the original plans and estimates submitted several years ago, that in my opinion the time would come when the vast commerce of this territory would demand the application of the lock and dam system to this river. And I must again note here, as applicable to all my annual reports, that while charged with a vast territory, well watered with navigable streams, the people inhabiting the territory are so little conscious of the resources they possess in their fertile fields, timbered hills, and mineral-stocked mountains and natural waterways that it is only by the most strenuous efforts that anything like an accurate showing of commerce can be obtained. I again repeat, also, that the White River has, at least, all the possibilities of the Tennessee River, with a margin in its favor.

It is my duty to state that the time has come, in view of the commerce, to take up the question of locks and dams. (See pp. 1406 and 1407, Annual Report Chief of Engineers, 1888.)

## COMMERCE.

The general statement in regard to commerce remains the same as in the report for 1891.

A number of enterprising citizens have responded to the inquiries for commercial statistics of this river during the past year, and agree that the improvement is of vast importance.

The following extract from a statement of Capt. T. B. Stallings is worthy of mention:

> There have been great advantages derived from the work done on the river from Batesville to McBee Landing; the channel has been deepened so that boats can make the trip on 6 inches less water than before the work was done, and if continued would do great good, as it would furnish transportation to the vast tonnage that would come down the river; otherwise it has to go overland.

| | |
|---|---|
| Tonnage ........................tons.. | 173,964 |

### *Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $85.61 |
| Amount appropriated by act approved July 13, 1892 | 75,000.00 |
| | 75,085.61 |
| June 30, 1893, amount expended during fiscal year | 26,284.10 |
| July 1, 1893, balance unexpended | 48,801.51 |
| July 1, 1893, outstanding liabilities | 8,921.81 |
| July 1, 1893, balance available | 39,879.70 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895<br>Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893. | 153,815.00 |

### *Expense account.*

| | | | |
|---|---|---|---|
| Pay roll | $13,754.28 | Medicine | $43.25 |
| General supplies | 3,038.05 | Skiffs and oars | 50.00 |
| Subsistence | 1,991.70 | Typewriter | 95.00 |
| Lumber | 1,542.28 | United States towboat *Henry Sheldon* | 4,500.00 |
| Fuel | 744.35 | Reserved in United States Treasury for freight charges | 54.77 |
| Traveling expenses | 162.04 | | |
| Stationery | 179.03 | | |
| Transportation | 39.35 | | |
| Rent | 85.00 | Grand total | 26,284.10 |
| Telephone rent | 5.00 | | |

## W 6.

### IMPROVEMENT OF CACHE RIVER, ARKANSAS.

The first appropriation ever made for this reach of river became available August 11, 1888.

Prior to this time the channel was choked with logs and snags; overhanging trees interfered with smokestacks, and several shoals interfered with low-water navigation.

The project proposes the removal of logs, snags, and overhanging trees from the town of Riverside, Ark., to the mouth of the river. This operation will incidentally improve these shoals, as they are caused in the majority of cases by an accumulation of logs. Seven thousand dollars was the amount appropriated; $3,000 for the construction of a snag boat and $4,000 for the operating expenses, working at or near extreme low water, the boat being constructed of light draft for this purpose.

Up to June 30, 1890, the entire sum except $7.11 had been expended. The snag boat was built and operated as far down as Walkers Ferry, leaving 35 miles of river yet to be worked. The boat was operated just as near low water as it could be moved and with a draft of only 14 inches. It will be seen that only the main channel could be worked, as it surely could be found at the low-water stage. The obstructions encountered were more formidable than the reconnoissance showed, one snag when lifted often bringing up several others.

By act approved July 13, 1892, $2,000 were appropriated.

During the fiscal year ending June 30, 1893, $2,825.58 were expended.

The boat was put in the field and operations commenced at the mouth of the river December 13, 1892, and worked to within about 8 miles of the town of Riverside, which point was reached March 8, 1893, when the funds became practically exhausted, and the boat was returned down the river as far as the Little Rock and Memphis Railway bridge, with a view of sending it to the Black River, but with the $2,000 made available by the sale of the boat to the appropriation, "Improving Black River, Arkansas and Missouri," by proper authority, it made it possible to do the much-needed work in this stream, and it was thought best to continue the work without her having to be returned to this river for the work after the Black River had been completed. The boat, therefore, resumed operations about April 12, 1893, and continued work until April 24, when high water stopped economical effective work at James Ferry, a point about 13 miles below the town of Riverside. During the season there were removed 278 snags, 2,299 overhanging trees were cut, and 16 drift piles destroyed. High water greatly interfered with the work during the entire season.

Farly in the next fiscal year work will be resumed at about 1.6 stage and it is believed the funds available will complete the work so far as the original project contemplated.

There is a demand for additional work to improve low-water navigation, which is undoubtedly needed, but this is beyond the approved plan. In doing pioneer work of this kind, the advance in the prosperity of the country often brings work that the original conditions did not warrant. This, however, belongs to the people, not to the engineer, but the engineer, in self-defense, should note it as under his cognizance.

## COMMERCE.

The general statement in regard to commerce remains the same as in the Report for 1891.

The following extract from a letter from Mr. A. F. Maberry, contains all new data available:

> There are several millions of dollars' worth of the finest timber up this river and at present it is very hard to get it marketed, the navigation is so bad. There are now stave boats ready to come up and buy our timber, if they could get up. The Memphis and Little Rock Railway Company have been the means of keeping boats out of the river for more than twenty years, by not having a draw in their bridge spanning this river, and we want something done by the General Government to relieve us of the blockade. Some seasons before this bridge was built, we had three boats running in this trade. Boats running here now would soon build up a good trade. The lands along the river are very fertile, and there are many large plantations along its shores.
>
> If the people knew they could get this river open to navigation, they would be very enthusiastic, but they have been subdued by the railway company so long they have about given it up.

| | | |
|---|---|---|
| Tonnage, logs | feet | 125,000,000 |

### *Money statement.*

| | |
|---|---|
| Received on account of sale of United States snag boat *Riverside* | $2,000.00 |
| Amount appropriated by act approved July 13, 1892 | 2,000.00 |
| | 4,000.00 |
| June 30, 1893, amount expended during fiscal year | 2,825.58 |
| July 1, 1893, balance unexpended | 1,174.42 |
| July 1, 1893, outstanding liabilities | 273.00 |
| July 1, 1893, balance available | 901.42 |

*Expense account.*

| | | | |
|---|---|---|---|
| Pay roll | $2,001.36 | Capstan | $375.00 |
| General supplies | 90.18 | Medicine | .50 |
| Subsistence | 321.10 | Deposited to credit of United States Treasury | 6.96 |
| Lumber | 1.68 | | |
| Traveling expenses | 14.80 | | |
| Stationery | 1.00 | Grand total | 2,825.58 |
| Transportation | 13.00 | | |

## W 7.

## IMPROVEMENT OF LITTLE RED RIVER, ARKANSAS.

No change in this report since last year.

The small balance, $167.12, available July 1, 1892, was expended in care of property and records.

### *Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $300.12 |
| June 30, 1893, amount expended during fiscal year | 300.12 |

*Expense account.*

| | |
|---|---|
| Pay roll | $294.00 |
| General supplies | 5.37 |
| Stationery | .75 |
| Grand total | 300.12 |

## W 8.

## IMPROVEMENT OF BLACK RIVER, ARKANSAS AND MISSOURI.

Before any improvements were made upon this river the magnificent timber which lines its banks overhung its narrow and deep channel, giants of the forest stretched across it from bank to bank in falling, dèbris from logging camps lodged in the same, producing shoals, all of which presented a formidable array of obstacles not only to navigation, but to any attempts at improving the same.

The original plan for its improvement contemplated the removal of the obstructions and the improvement of the shoals, the latter by wing dams. A few sloughs were to be closed so as to confine the water to the main channel. The work has been steadily carried forward with very small appropriations at irregular intervals for upwards of fourteen years. In the earlier operations the appliances were not adapted to the heavy work on hand. In latter years suitable appliances having been secured more rapid progress has been made. Its channel being narrow, water deep, and banks firm it is one of the most satisfactory streams in this district to improve.

Up to June 30, 1892, $65,961.44 had been expended in carrying out the above plan, giving a very good river from the mouth up to the mouth of Current River, making a visible impression upon the formidable obstructions between that point and Poplar Bluff, Mo., in conjunction with the appropriation under the heading, "Improving Black River, Missouri."

During the fiscal year ending June 30, 1893, $6,178.28 was expended. After undergoing much needed repairs, the boat was put into the field September 1, and operated from Poplar Bluff, Mo., to the mouth of the river, which point was reached November 30, 1893. On this reach of river, a distance of about 253 miles, 818 snags were removed, 9,315 trees cut, and 24 masses of driftwood destroyed, making effective work and clearing the river of obstructions.

After reaching the mouth of the river the boat was returned to the Cache River, to which apppropriation it belonged, and was afterwards sold (by proper authority) to the appropriation "Improving Black River, Arkansas and Missouri," but it was thought best to do the necessary work in the Cache River with the funds made available by this sale while the boat was in that river, rather than to return it to this work after the Black River work had been completed.

The sale of the United States snag boat *Henry Shelden*, belonging to this appropriation (by proper authority), to the appropriation "Improving White River, Arkansas," made it possible to do more work upon the Black River.

The deserving character of this stream, on account of its deep water and permanent banks, the magnificent territory drained by the river, rich in the finest agricultural lands and splendid timber, a country susceptible practically of unlimited development, and settling up with a good class of people, combined, call aloud for due attention to their commercial interests.

It would seem like a redundancy to reiterate facts that have so often appeared in my annual reports in regard to the great benefits to be conferred by the opening of this river and to the deserving character of the stream, on account of its deep water and permanent banks, yet, as I come to know this stream more and more thoroughly from year to year, I am more convinced that the recommendations made in the past should not only be renewed but emphasized in their renewal. My plan has been to secure an annual contingent of $8,000 for this work, but this has been departed from so far in the amounts of the appropriations that nothing less than $42,000 would adequately meet the requirements of the situation. It may be stated that with the expenditure of this sum as a whole a magnificent artery of commerce would be effectively opened, which would need but very little attention for its maintenance.

### COMMERCE.

No new data has been secured in regard to commerce since last report.

| | |
|---|---|
| Tonnage ........ tons.. | 51,950 |

### *Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $280.96 |
| Received on account of sale of United States towboat *Henry Sheldon* | 4,500.00 |
| Amount appropriated by act approved July 13, 1892 | 5,000.00 |
| | 9,780.96 |
| June 30, 1893, amount expended during fiscal year | 6,178.28 |
| July 1, 1893, balance unexpended | 3,602.68 |
| July 1, 1893, outstanding liabilities | 2.75 |
| July 1, 1893, balance available | 3,599.93 |
| Amount (estimated) required for completion of existing project, annually | 8.000.00 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895 | 42,000.00 |
| Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893. | |

### *Expense account.*

| | | | |
|---|---|---|---|
| Pay roll | $3,031.01 | Rent | $85.00 |
| Subsistence | 628.75 | Medicine | 5.15 |
| General supplies | 213.14 | Reserved in United States Treasury for freight charges. | .61 |
| Lumber | 62.50 | | |
| Traveling expenses | 112.92 | | |
| Stationery | 35.70 | Grand total | 4,178.28 |
| Transportation | 3.50 | | |

## W 9.

## IMPROVEMENT OF BLACK RIVER, MISSOURI.

No change in this report since last year.

The small balance, $20.59, available July 1, 1892, was expended in the care of the property and records.

### *Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $95.59 |
| June 30, 1893, amount expended during fiscal year | 95.59 |

*Expense account.*

| | |
|---|---|
| Pay roll | $76.20 |
| General supplies | 15.34 |
| Subsistence | 3.90 |
| Stationery | .15 |
| Grand total | 95.59 |

---

## W 10.

### IMPROVEMENT OF ST. FRANCIS RIVER, ARKANSAS.

Earliest appropriations made for this river under any head were made by act approved March 2, 1893.

Summing up all the various works of improvement, it may be inferred that prior to 1833 this river was much choked with drift piles, logs and snags, its waters spread out through a great variety of sloughs, while overhanging trees added to the difficulties of navigation. In the originally adopted project snagging operations figured largely, and attempts have been made to close up some of the many sloughs.

This river has been united so often with the White River and also with the Black River, that it is impossible to give exactly how much had been expended upon the St. Francis River to June 30, 1884. From June 30, 1884, to June 30, 1890, $24,000 were appropriated; $12,000 in 1884, $8,000 in 1886, and $4,000 in 1888, and this had been practically expended. The history of its expenditure is the history of all work in new countries with entirely inadequate appropriations made over long reaches of river. Most constant and careful study has been given to making the money do as much work as possible. The snag boat *Johnson* was first designed for this river, and its light draft, great power, and light running expenses were first utilized on this river. A vast amount of very hard pioneer work has been done. Once or twice sickness in the swamps has demoralized the crew. Diverse interests have opposed the boat's progress here and there, but with steady persistence the work has been carried on, looking to the ultimate opening of the river as contemplated in the original project. The little reach above the Sunk Lands has been well opened and greatly to the advantage of commerce. The transfer of the boat has caused great delay. This has been obviated by building a separate twin boat partly out of the appropriation to operate above the Sunk Lands in conjunction with the appropriation, "Improving St. Francis River, Missouri."

Up to June 30, 1892, $27,956.86 had been expended as individual or distinct appropriations for this river.

During the fiscal year ending June 30, 1893, $3,795.61 was expended.

The boat was put into the field late in September, 1892, and effective operations carried on from the town of Madison, Ark., to the mouth of the river, a reach of river of about 65 miles in length and badly in need of work. One thousand and forty-six snags were removed, 9 drift piles destroyed, and 446 overhanging trees cut.

This work was between September 25 and November 23, 1892.

The season for active operations on this stream being practically at an end, the boat was laid up on the latter date, at Madison, Ark.

### COMMERCE.

No new data has been secured in regard to commerce since last report.

| | |
|---|---|
| Tonnage ........ tons.. | 70,000 |

### *Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $43.14 |
| Amount appropriated by act approved July 13, 1892 | 8,000.00 |
| | 8,043.14 |
| June 30, 1893, amount expended during fiscal year | 3,795.61 |
| July 1, 1893, balance unexpended | 4,247.53 |
| July 1, 1893, outstanding liabilities | 135.20 |
| July 1, 1893, balance available | 4,112.33 |
| Amount (estimated) required for completion of existing project, annually | 8,000.00 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895 | 28,000.00 |

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

### *Expense account.*

| | | | |
|---|---|---|---|
| Pay roll | $2,858.52 | Rent | $80.00 |
| General supplies | 162.27 | Medicine | 7.05 |
| Subsistence | 528.84 | | |
| Lumber | 1.84 | | 3,786.94 |
| Fuel | 13.30 | Reserved in the United States Treasury for freight charges | |
| Traveling expenses | 74.85 | | 8.67 |
| Stationery | 36.21 | | |
| Transportation | 24.06 | Grand Total | 3,795.61 |

## W II.

## IMPROVEMENT OF ST. FRANCIS RIVER, MISSOURI.

The first appropriation made for this work was that of $5,000 by act of August 11, 1888. Prior to this time the river channel was choked with logs and snags, overhanging trees interfered with the smokestacks, and several shoals interfered with low-water navigation. The original project contemplated the removal of the shoals 12 miles below Greenville, Mo., the removal by a snag boat of stumps, snags, and overhanging trees from Greenville, Mo., to the town of St. Francis, Ark.

Up to June 30, 1890, $5,000 had been expended opening up very thoroughly the river from Greenville, Mo., to a point about 80 miles above St. Francis, Ark. A few obstructions were removed over this latter reach.

By act approved September 19, 1890, $10,500 were appropriated to carry on the work. As much trouble had been experienced in getting the snag boat *A. B. Johnson* through the Sunk Lands, this being a barrier impassable except at extreme high water, and being a natural division of the river into its districts, rather than the arbitrary one at St. Francis, Ark., proper authority was secured to build a snag boat the duplicate of the *Johnson*, to operate above the Sunk Lands altogether, leaving the *Johnson* for the work below, and also for the work in Little River.

During the fiscal year ending June 30, 1891, this boat was built and equipped. From the time the boat was completed to the close of the fiscal year, the water was too high for effective operations.

During the fiscal year ending June 30, 1892, $4,687.09 were expended between the town of St. Francis, and the Big Drift, 70 miles up the river.

The $3,000 made available by the sale of the boat belonging to this river to the appropriation "Removing obstructions in the Arkansas River, Arkansas and Kansas," by proper authority, made it possible to do much needed work on this stream.

During the fiscal year ending June 30, 1893, $3,186.24 was expended. The boat took the field about April 1, 1893, and commenced operations about 70 miles above the town of St. Francis, Ark., at the Big Drift. A channel of 3 feet to 15 feet in depth and 75 feet to 150 feet in width was cleared through the obstruction, about 3 acres of drift being removed in the operations.

After this was completed the boat continued operations down the river to the town of Kennet, Mo., about 45 miles below St. Francis, which point was reached on May 13. There were removed during this time 346 snags, 1,097 overhanging trees were cut, 58 drift piles destroyed, and 21 heavy snags and drift jams broken up and destroyed.

As before stated, operations stopped at the Big Drift, consequently the shoals 12 miles below Greenville were not reached. In the near future this reach of river will require careful attention; the territory is a rich and fertile one, and some judicious effort to overcome these shoals in the interest of low-water navigation will be a demand in the interest of the increased commerce.

The claim supposed to be presented by the Dunklin County Transportation Company for a cut-off owned by them and for which the act provides payment, has not yet been presented, and, as stated in a former report, it is doubtful if it ever will be.

Two thousand dollars, however, has been reserved to meet this, if ever presented. This money will eventually be applied either to improve the cut-off or the old river, as may seem most expedient. The increase in commerce in the upper river warrants an expenditure of additional money between St. Francis and Greenville. According to law, however, I apprehend that any estimates would not be in order in this report, as it would be new work.

## COMMERCE.

No new data has been secured in regard to commerce since last report.

| | |
|---|---|
| Tonnage ....tons.. | 70,000 |

### *Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $3,170.23 |
| Received on account of sale of United States snag boat *Missouri* | 3,000.00 |
| | 6,170.23 |
| June 30, 1893, amount expended during fiscal year | 3,186.24 |
| July 1, 1893, balance unexpended | 2,983.99 |
| July 1, 1893, outstanding liabilities | 48.69 |
| July 1, 1893, balance available | 2,935.30 |

*Expense account.*

| | |
|---|---|
| Pay roll | $2,462.81 |
| General supplies | 183.81 |
| Subsistence | 454.84 |
| Lumber | 1.95 |
| Fuel | 1.12 |
| Traveling expenses | 72.05 |
| Transportation | 1.00 |
| Medicine | 8.18 |
| | 3,185.76 |
| Reserved in United States Treasury for freight charges | .48 |
| Grand total | 3,186.24 |

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## W 12.

### IMPROVEMENT OF LITTLE RIVER, MISSOURI.

No change in this report since last year.

The small balance, $20.52, available July 1, 1892, was expended in the care of property and records.

*Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $20.52 |
| June 30, 1893, amount expended during fiscal year | 20.52 |

*Expense account.*

| | |
|---|---|
| Pay roll | $0.25 |
| General supplies | 11.04 |
| Subsistence | 6.98 |
| Stationery | 2.25 |
| Grand total | 20.52 |

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## W 13.

### REMOVING SUNKEN VESSELS OR CRAFT OBSTRUCTING OR ENDANGERING NAVIGATION.

On July 20, 1892, the wreck of the steamer *John Matthews*, in the channel of the Arkansas River at Van Buren, Ark., which lay half buried in water against the piers of the bridge of the St. Louis and San Francisco Railway Company, was reported to the Secretary of War by that company as an obstruction to navigation and a menace to their property.

In accordance with instructions contained in fourth indorsement on this paper, dated Office Chief of Engineers, U. S. Army, August 13, 1892, and approved by the Secretary of War under date of August 16, 1892, in which an allotment of $800 was recommended to be made from the permanent indefinite appropriation provided by act of June 14, 1880, for removal of sunken vessels or craft obstructing or endangering navigation, the proper steps for the removal of this obstruction were taken as provided for in chapter 211, Supplement to the Revised Statutes of the United States.

The sum of $401.30 was expended in the removal of this obstruction. The U. S. snag boat *Wichita* was dispatched to the scene of the wreck and commenced operations on February 7, 1893, and on the 14th of the month had succeeded in removing this obstruction to navigation.

*Money statement.*

| | | |
|---|---|---|
| Amount allotted under act of June 14, 1880 | | $800.00 |
| Deposited to credit of United States Treasury | $398.70 | |
| June 30, 1893, amount expended during fiscal year | 401.30 | |
| | | 800.00 |

---

*Expense account.*

| | |
|---|---|
| Pay roll | $282.33 |
| General supplies | 16.28 |
| Subsistence | 43.87 |
| Traveling expenses | 9.80 |
| Fuel | 42.02 |
| Advertisements | 2.00 |
| | 401.30 |
| Deposited to credit of United States Treasury | 398.70 |
| Grand total | 800.00 |

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## W 14.

## PRELIMINARY EXAMINATION OF SALINE RIVER, ARKANSAS.

[Printed in House Ex. Doc. No. 236, Fifty-second Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
*Washington, D. C., February 2, 1893.*

SIR: I have the honor to submit the accompanying copy of report dated January 24, 1893, upon preliminary examination of Saline River, Arkansas, made by Capt. H. S. Taber, Corps of Engineers, in compliance with the provisions of the river and harbor act approved July 13, 1892.

It is the opinion of Capt. Taber that Saline River is worthy of improvement to the extent of removing snags and other obstructions. In view, however, of the sparse development of the tributary country, notwithstanding the expenditure of $20,000 in work upon this river, the Division Engineer, Col. C. B. Comstock, Corps of Engineers, does not consider the river worthy of improvement by the United States. I concur in the opinion of the division engineer.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
*Brig. Gen., Chief of Engineers.*

Hon. S. B. ELKINS,
*Secretary of War.*

## REPORT OF CAPT. H. S. TABER, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
*Little Rock, Ark., January 24, 1893.*

GENERAL: I have the honor to submit herewith the following report of the preliminary examination of the Saline River, Arkansas, in compliance with the provisions of river and harbor act of July 13, 1892.

Already having in my office the data of a thorough preliminary examination of this river to a point 320 miles above its mouth, made in January, 1887, it only remained to collect commercial statistics of a later date or up to the present time, to enable me to make a very full report upon the matter.

A competent man of experience was engaged for the purpose and whose report will be found appended.

A reference to Annual Report Chief of Engineers, 1887, p. 1546, will show a statement to the effect that in the reach of river from Big Island to a point 60 miles above there is only water enough for navigation from February to June 1. It is only a question of water, as there are no obstructions, except the railroad bridge.

A very careful examination was made, but as there could be nothing done to increase the supply of water it does not seem desirable to enter into details.

> As to the reach from Big Island to the mouth, a distance of 260 miles, my annual report for 1885, p. 1598, Annual Report Chief of Engineers, 1885, states that work was completed upon this reach December, 1884, and that the river was left in a good navigable condition at medium stages, as high as Longview, and at high water as high as Mount Elba, a point 28 miles above Big Island.

As to the necessity of further improvement of the reach from Big Island to the mouth, on p. 1598, Annual Report Chief of Engineers, 1885, after careful consideration, I state—

> That this will at some time be a valuable artery of commerce there seems little room for doubt, but at present the country is not sufficiently settled. It would seem advisable, now that it is pretty well cleaned out, to watch the results in the way of developing the country before another appropriation is made. * * * The question of further improvement is left contingent upon the result of the work done so far.

Again, on p. 1388, Annual Report Chief of Engineers, 1886, I state:

> There was expended on this river up to June 30, 1885, $20,951.70. This has given much relief to navigation and practically cleared the river so far as present navigation demands.

Since December, 1884, no work has been done on this river, and consequently it is more or less obstructed with snags and overhanging trees, and at one point, 9 miles above Saline and some distance below Big Island, an immense "rack heap" or "boom," composed of drift and heavy logs has formed, reaching from bank to bank and about 250 yards in length, completely obstructing navigation. No further examination will be necessary to enable me to submit plans and estimates for the improvement of the navigable reach of this river.

In view of the foregoing facts and statements, I am of the opinion that the river is worthy of improvement so far as it relates to the removal of snags, logs, drift, the cutting of overhanging trees, and the removal of the obstructions above Saline mentioned above. No further survey will be required to submit an estimate.

* * * * * * *

Before closing this report I respectfully invite attention to the reports referred to above for more detailed statements in the premises, if required.

I am, sir, very respectfully, your obedient servant,

H. S. TABER,
*Captain of Engineers.*

Brig. Gen. THOMAS L. CASEY,
*Chief of Engineers, U. S. A.*

(Through Col. C. B. Comstock, Corps of Engineers, Division Engineer, Southwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
SOUTHWEST DIVISION,
*New York, January 31, 1893.*

Respectfully forwarded to the Chief of Engineers.

The headwaters of the Saline River are about 120 miles from its mouth, in a direct line.

Up to June 30, 1885, $20,951.70 had been expended, and the river was reported in excellent condition; but it was also reported that there was little commerce on the river. It would appear from the present report that, in spite of the $20,000 formerly spent, it is difficult to estimate the commerce, as the country is but sparsely developed.

Under these circumstances I do not think the river worthy of improvement by the United States.

C. B. COMSTOCK,
*Colonel of Engineers, Bvt. Brig. Gen., U. S. A.,*
*Division Engineer.*

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### REPORT OF MR. A. WALKER, JR., OVERSEER, UPON COMMERCIAL STATISTICS OF SALINE RIVER FROM RISON, ARK., TO WARREN, ARK.

U. S. TOWBOAT CLEVELAND, *January 10, 1893.*

CAPTAIN: I have the honor to submit the following report of the commercial statistics of Saline River, Arkansas, from a point near Rison, Ark., to Saline, Ark.

According to your orders, I proceeded to Rison, Ark., by the shortest possible route, viz: via the Arkansas Valley Railroad to Pine Bluff, thence via St. Louis, Arkansas and Texas Railroad to Rison, Ark.; thence via hack to McKinnis's sawmill.

The bridge of the St. Louis, Arkansas and Texas Railroad at this point (McKinnis's sawmill) is so low as to obstruct the passage of stave boats and rafts. I had no means of ascertaining the stage of the water in the river, but it was within 2 feet of the lower stringers of the bridge the time of my inspection, December 28, 1892. This bridge has occasioned a great amount of wreckage both to stave boats and rafts, and is a great source of annoyance to those who use the river for transportation.

Mr. W. C. McKinnis, who has located a new sawmill near the bridge crossing and who has just lately returned from a trip of inspection of the upper river, estimates that there are 200,000 acres of good timber land which will cut about 3,500 feet to the acre, of pine, gum, cypress and oak. Mr. McKinnis expects to commence running his logs this spring and will operate from above. At low water, eight stave barges passed through the bridge this year (1892) with cargoes of 35,000 barrel staves (oak) per barge; these barges are floated to Monroe, La., and points below on the Mississippi River.

There are but three farms which lie directly on the Saline river, most of the farms being from 1 mile to 5 miles back from the river; these farms are very fertile and fairly well cultivated. I estimate that there are about 10,000 acres of land cultivated in cotton and corn between Rison and Warren, Ark., contingent to the river. The products from these farms are hauled overland to Rison, Kingland, Warren, Monticello, and even to Pine Bluff, a distance of from 10 to 30 miles. No estimate of live stock can be given, but it is large. There are no towns along the Saline river, and at the present stage of high water but very little logging and rafting are being done, and but few choppers are at work.

Below Loves Ferry I saw at least 3,000,000 feet of pine, oak and cypress logs along the banks waiting to be rafted to Gates's Mill, which is located about 5 miles above the bridge at Saline, Ark.; besides these logs there are about 150,000 oak barrel staves piled along the banks. The farmers and timbermen complain bitterly of the lack of transportation, and the Saline River is the natural and at present the only highway for this large section of country. The river could, if kept in good condition, draw its commerce from 15 miles from either bank, without competition. Most of the lands are what are termed "bottom lands," and will yield on an average of 65 bushels of corn or 400 pounds of ginned cotton to the acre, but the lands are opening up very slowly, owing to the lack of transportation. From Rison to Warren, a distance of about 50 miles by water, the river banks are lined with a fine growth of oak, gum and cypress of large size and thick growth. No products are transported down the river except the products from the timber, such as staves, logs, crossties, etc.

Just above Gates's sawmill and about 9 miles above the bridge at Saline, is an immense "rack heap," which reaches from bank to bank and about 250 yards long, completely cutting off the river navigation; this "rack heap" is mainly due to pine-log rafts which have been run down against the drift and snags, and have sunk in the channel. This "rack heap" is so firmly packed that no pressure from water above could possibly move it.

It is a difficult matter to estimate the commerce of Saline River, as the country is but sparsely developed owing to lack of transportation.

If the river was put in a navigable condition it would be the means of opening up this country.

Very respectfully, your obedient servant,

A. WALKER, JR.,
*Overseer.*

Capt. H. S. TABER,
*Corps of Engineers, U. S. A.*

## W 15.

## PRELIMINARY EXAMINATION OF FOURCHE LE FEVRE RIVER, ARKANSAS.

[Printed in House Ex. Doc. No. 226, Fifty-second Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
*Washington, D. C., February 1, 1893.*

SIR: I have the honor to submit the accompanying copy of report of the 21st ultimo from Capt. H. S. Taber, Corps of Engineers, of the results of preliminary examination of Fourche Le Fevre River, Arkansas, made to comply with provisions of the river and harbor act approved July 13, 1892.

It is the opinion of Capt. Taber, concurred in by the division engineer and by this office, that this river is not worthy of additional improvement by the General Government at the present time.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
*Brig. Gen., Chief of Engineers.*

Hon. S. B. ELKINS,
*Secretary of War.*

## REPORT OF CAPT. H. S. TABER, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
*Little Rock, Ark., January 21, 1893.*

GENERAL: I have the honor to submit herewith the following report of preliminary examination of Fourche Le Fevre River, Arkansas, in compliance with river and harbor act of July 13, 1892.

In August, 1886, a thorough examination of the entire navigable reach of this river, with the exception of 3 miles, was made in person. and from special report of the assistant engineer upon the other 3 miles a very full report was made. I refer to Annual Report Chief of Engineers, 1887, pp. 1533, 1534.

It seemed hardly necessary with this data available that a new examination should be made, but in view of the fact that the increased demands of commerce might warrant the improvement of this river, a competent man of experience was engaged to collect commercial statistics through the country watered by this stream, and whose report is appended.

In the report of the preliminary examination referred to above will be found the following paragraph:

> Piney Shoal is perhaps a half mile in extent, and consists of a flat ledge. But little could be done for this, except to remove a few loose rocks. It would require a lock and dam to pass even light-draft boats over this shoal. The demands of commerce at present would hardly warrant the expense incident to this improvement.

I reiterate the words used at that time. I do not think commerce has sufficiently increased to demand this improvement.

Since October, 1891, no work has been done on the river. At that time the Whaleback Rock at Red Ferry was removed to the depth of 5 feet. The square section through May Shoals was completed. Piney Shoal was cleared of obstructions by the removal of snags, logs and rocks. During the season was also removed a large number of snags, several thousand overhanging trees cut, many hundred trees deadened, and many drift piles destroyed, giving to the river a high and medium stage navigation from the mouth to Perryville Landing.

It is believed that the work accomplished, together with that proposed under present appropriation, will answer all the present needs of commerce—for several years at least.

The boat belonging to this stream has been sold to "Improving Arkansas River, Arkansas," and the proceeds, $3,500, with the amount on hand, to be used in the work on the river.

Based on the aforementioned facts and statements, I am of the opinion still that Fourche Le Fevre River, Arkansas, is not worthy of additional improvement by the General Government at the present time.

I am, sir, very respectfully, your obedient servant,

H. S. TABER,
*Captain of Engineers.*

Brig. Gen. THOMAS L. CASEY,
*Chief of Engineers, U. S. A.*

(Through Col. C. B. Comstock, Corps of Engineers, Division Engineer, Southwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
SOUTHWEST DIVISION,
*New York, January 30, 1893.*

Respectfully forwarded to the Chief of Engineers.

For the reasons stated by the district engineer, I do not think this river worthy of further improvement at present by the United States.

C. B. COMSTOCK,
*Colonel of Engineers, Bvt. Brig. Gen., U. S. A.,*
*Division Engineer.*

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### REPORT OF MR. A. WALKER, JR., OVERSEER, UPON COMMERCIAL STATISTICS OF FOURCHE LE FEVRE RIVER, FROM PERRYVILLE, ARKANSAS, TO ITS MOUTH.

LITTLE ROCK, ARK., *January 13, 1893.*

CAPTAIN: Pursuant to your orders, I proceeded to Fourche Le Fevre River, by the shortest possible route, viz: via the Little Rock and Fort Smith Railroad to Morrilton; thence via hack to Perryville, Ark.

*Perryville.*—Perryville is the county seat of Perry County and is situated directly on the Fourche Le Fevre River, and is about 32 miles from its mouth. It is at present the head of navigation. It has a population of 400 inhabitants, 5 general merchandise stores, 2 drug stores, 2 grocery stores, 2 hotels, 1 cotton gin, 3 blacksmith shops, and 1 sawmill with a capacity of 5,000 feet of sawed lumber per day.

The imports of Perryville are chiefly merchandise, groceries, and drugs, of which 600 tons is received annually. Its exports are 2,000 bales of cotton, 800,000 feet of lumber, 800 head of cattle, 500 head of hogs, 8,000 bushels of corn, and 500 tons of cotton seed. These imports and exports are by river transportation, except that which is hauled overland to the Little Rock and Fort Smith Railroad; and inasmuch as these roads run through a low country the hauling has to be abandoned during the winter or wet months, at which time the shippers are entirely dependent upon the river transportation, which is afforded them by the steamboats *Annie Adams, Mary Morgan*, and *Border City*.

Below Perryville to the mouth, there are no towns or stores of any importance whatever. The lands lying along the river, and which are almost totally dependent upon that stream for their transportation of products, are very fertile, producing 65 bushels of corn or three-fourths of a bale of cotton to the acre.

Out of the 64 miles of river frontage, from Perryville to the mouth and back, a distance of 5 miles from either bank, there are about 20,000 acres of land in cultivation, producing 5,000 bales of cotton and about 100,000 bushels of corn. About one-half of this land is subject to overflow and almost total loss of crops. The banks of the river are lined with fine timber, mostly cypress, oak, pine and ash.

Rankins mill, near the bank of the river and about 4 miles below Perryville, has a capacity of 4,000 feet of sawed lumber per day. Lawson's cotton gin, near the mouth of the river, gins from 400 to 500 bales of cotton per annum.

There are seven regular landings along the river between Perryville and the mouth of the river, but as there are no storehouses, and no one lives at them, no estimate of their shipments can be obtained.

The transportation by boat is very uncertain on account of their irregularity in running, and 70 per cent of the products of this country find their way to the railroad, a distance overland of from 10 to 25 miles, and over the most fearful swampy roads.

About 1,000,000 feet of logs in rafts are lying on or tied to the banks, awaiting rafting to Little Rock, Ark., the market for most of the timber from the Fourche Le Fevre River.

This year (1892) has been a poor year for the timber men operating in this section, but it is expected that the trade will be more than trebled during 1893, as the last poor crops have induced many men to embark in this line of business.

The commerce of this river could be greatly extended if there was one packet making regular trips, so that the shippers could depend upon them and have some certain date for shipment.

Very respectfully, your obedient servant,

A. WALKER, JR.,
*Overseer.*

Capt. H. S. TABER,
*Corps of Engineers, U. S. A.*

## W 16.

## PRELIMINARY EXAMINATION OF CURRENT RIVER, ARKANSAS.

[Printed in House Ex. Doc. No. 227, Fifty-second Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
*Washington, D. C., February 1, 1893.*

SIR: I have the honor to submit the accompanying copy of report, dated January 17, 1893, upon preliminary examination of Current River, Arkansas, made by Capt. H. S. Taber, Corps of Engineers, under the provisions of the river and harbor act approved July 13, 1892.

Capt. Taber considers the river to be worthy of improvement by the General Government, and states that no further survey is necessary to enable him to prepare plans and estimates for the work.

The Division Engineer, Col. C. B. Comstock, Corps of Engineers, deems Current River, Arkansas, "worthy of some small improvement by snagging." This opinion is concurred in by me.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
*Brig. Gen., Chief of Engineers.*

HON. S. B. ELKINS,
*Secretary of War.*

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## REPORT OF CAPT. H. S. TABER, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
*Little Rock, Ark., January 17, 1893.*

GENERAL: I have the honor to submit herewith the following report of the preliminary examination of the Current River, Missouri and Arkansas, in compliance with the provisions of the river and harbor act of July 13, 1892.

Already having data in my office of a preliminary examination of this river made in October, 1890, it only remained to collect commercial statistics of a late date, or up to the present time, to allow me to make a very full report upon the matter.

A competent man of experience was engaged for the purpose, and whose report will be found appended.

A reference to the Annual Report, Chief of Engineers, 1891, Part 4, pp. 2067 to 2071, will show a very full report of an examination made of this stream by an experienced engineer.

Taking the facts as presented in the appended report, in connection with the examination previously made, which show a wonderful increase of inhabitants and commerce along this river in the last two years, I can only reiterate that this stream is worthy of improvement, and the outlay necessary for the same is fully warranted by the interest involved. No further examinations will be necessary to enable me to submit plans and estimates for the improvement of the navigable reach of this river. In the report referred to above, the following paragraph occurs:

> It appears that there are 95 miles of this river from the mouth to Van Buren, Mo., that are navigable throughout the whole year, as there is an abundance of water. The discharge at Van Buren at a low-water stage is 2,200 cubic feet per second. About 4 miles below this point is a large spring which affords 700 cubic feet more.

The average width at low-water stage is 200 feet, and the velocity 2.75 miles per hour. The flood oscillation is about 16 feet. The Current River at time of flood is very swift, and has a tendency to clear the channel of obstructions in the way of snags, though many large clay-filled roots, too obstinate to be moved in this way, are lodged in the channel and make serious obstructions to navigation. Other obstructions, in the way of shoals, may be readily improved by a system of wing dams, built of rock and willow brush, for the purpose of contracting the channel.

This style of wing dam has been successfully operated on Upper White River. The commerce demanding the improvement of this river is approximately estimated to be 140,000 tons of lumber per annum in Carter County, Mo., besides 21 sections of undeveloped mineral lands (iron and lead), of which I have specimens now in my office that will compare favorably with the ores of Iron Mountain and De Loze lead mines, Missouri.

Van Buren alone, the county seat of Carter County, exports 800 car loads of lumber annually, and the town of Grandin, 5 miles from the river, 2,500 cars per annum, besides millions of feet which are floated down the river to other markets, and which estimates, it is believed, would be trebled if the river could be safely navigated.

In Ripley County, 45,000 or 50,000 tons of lumber, 5,000 bales of cotton, and over 300 car loads of merchandise received. From the State line to the mouth in Arkansas over 40,000 tons of lumber, 4,000 bales of cotton, besides grain and merchandise.

* * * * * * *

The railway bridge, which spanned the river 3 miles below Van Buren at the time of the previous examination and which was a serious obstruction to navigation, has been removed by the railway company, leaving, however, some piles still in the river, which are a dangerous obstruction to navigation. It is presumed there will be no trouble in this matter, as the railway company will likely comply with the law, when navigation demands the use of the river.

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I am, sir, very respectfully, your obedient servant,

H. S. TABER,
*Captain of Engineers.*

Brig. Gen. THOMAS L. CASEY,
*Chief of Engineers, U. S. A.*

(Through Col. C. B. Comstock, Corps of Engineers, Division Engineer, Southwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
SOUTHWEST DIVISION,
*New York, January 23, 1893.*

Respectfully forwarded to the Chief of Engineers.

The river and harbor act of July 13, 1892, requires a preliminary examination of Current River, Arkansas.

The report of the Chief of Engineers, 1891, p. 2068, states that the Arkansas line is at present the head of steamboat navigation.

This is about 42 miles from the mouth of the river, and is supposed to be the same as Pittmans Landing.

For the reasons stated by the local engineer the Current River, Arkansas, is deemed worthy of some small improvement by snagging.

C. B. COMSTOCK,
*Colonel of Engineers, Bvt. Brig. Gen., U. S. A.,*
*Division Engineer.*

### REPORT OF MR. A. WALKER, JR., OVERSEER.

LITTLE ROCK, ARK., *December 26, 1892.*

CAPTAIN: I have the honor to submit the following report of commercial statistics of Current River from Van Buren, Mo., to its mouth:

Pursuant to your orders, I proceeded to Van Buren, Carter County, Mo., by the shortest possible route, viz: via the St. Louis, Iron Mountain and Southern Railroad to Williamsville, Mo., thence via the Cape Girardeau and Southwestern Railroad to Hunter, Mo., and thence via the Current River Railroad to Chicopee, Mo., a small station across the river from Van Buren, Mo.

*Van Buren, Missouri.*—Van Buren is the county seat of Carter County, Mo., and is a thriving town of 300 inhabitants. It has 5 general merchandise stores, 2 hotels, 2 blacksmith shops, 1 flour, corn, and grist mill, and 1 livery stable. Within a radius of 4 miles of Van Buren, and situated on the river, there are 5 sawmills with a combined capacity of 100,000 feet of sawed lumber per day.

Between Jacks Fork and Van Buren, a distance of 25 miles, it is estimated that there are 900,000,000 feet of pine timber now standing on and near the river bank; 5,000,000 feet of pine logs were floated down the river to Van Buren this year. This is not considered a large float, as the bad condition of the upper river makes it a hazardous undertaking, and 15,000,000 feet of logs would have been rafted if the river had been in good condition; 20,000 cedar logs or posts passed Van Buren during the year, not including the hickory, ash, and oak, of which I could obtain no reliable estimate. This timber is for points below, such as Newport, Ark., and as far down as points on the Mississippi River.

Four thousand five hundred acres of cultivated land lie on and adjacent to the river between Jacks Fork and Van Buren. The products from these farms are corn, wheat, rye, and live stock. These products are hauled and driven overland to stations on the Kansas City, Fort Scott and Memphis Railroad, or to Van Buren, a distance of from 5 to 25 miles. Owing to the serious disadvantage of having no other means of marketing their products, these lands are not opening up as rapidly as would be expected, considering their fertility and cheapness.

Within 2 miles of Van Buren, and immediately on the river, is a granite quarry now leased by Messrs. Brown & Burks, of Kansas City, Mo. This granite is of a rich, dark red color, dresses easily and has successfully stood all tests as to durability and strength.

Van Buren exports 800 carloads of lumber per annum, averaging 40,000 pounds to the car, but no estimate could be obtained as to its other shipments, which are wheat, corn, and live stock; these products are not sent to Van Buren for shipment, but are hauled overland to the main lines of the railroad. The imports are mainly merchandise, flour, and groceries, and amount to 360 tons for the present year.

The minerals, which are mostly lead, iron, copper, and zinc, are as yet undeveloped, although fine specimens can be seen at Van Buren.

About two years ago the Current River Railroad constructed a wooden bridge across the river at a point nearly opposite Van Buren; this bridge was built so as to enable them to get to a gravel bank. It caused such obstruction to navigation and rafting that a request was made by the lumbermen for its removal; the railroad company tore the bridge away, but left some of the piling standing, which has now become very dangerous, owing to the channel of the river changing. They have requested the railroad officials to remove this piling, but no attention has been paid to their requests.

*Chicopee.*—Chicopee is a small station on the Current River Railroad, across the river from Van Buren. It has 75 inhabitants, one general store, one blacksmith shop, and one sawmill with a capacity of 15,000 feet of sawed lumber per day.

*Keenes Mill.*—Keenes Mills is 6½ miles below Van Buren. It has a capacity of 30,000 feet of sawed lumber per day; near the mill is one general merchandise store. The population is 25 inhabitants.

*Chilton.*—Chilton is situated on the river about 1½ miles below Keenes Mill. Its population is about 50 inhabitants. It has two grocery stores, one general merchandise store, one clothing store, one restaurant, and two sawmills with a combined capacity of 50,000 feet of sawed lumber per day. Their imports, mostly merchandise, flour, and groceries, were about 100 tons for this year. Exports chiefly consist of pine lumber, of which article 400 cars were shipped for 1892.

*Grandin.*—Grandin is the terminus of the Current River Railroad, 12 miles below Chilton and about 5 miles from the river. At this point is located the large sawmill of the Missouri Lumber and Mining Company, which has a capacity of 80,000 feet of sawed lumber per day.

Grandin is a flourishing town of about 300 inhabitants. It has 4 general merchandise stores, 2 grocery stores, 2 drug stores, and 1 livery stable.

No estimate could be obtained as to its imports. Its exports are chiefly lumber, shipping 2,500 cars per annum, averaging 40,000 pounds to the car. From Grandin down to Doniphan, a distance of about 25 miles, the river is lined with pine and oak timber of fine size and thick growth. Here and there are small farms and portable sawmills. In the bottoms and small coves the land is cultivated, is very fertile, and produces good crops. Many acres of new land have been cleared and opened up this year. I estimate that there are 3,000 acres under cultivation between Doniphan and Grandin. This land will produce about 50 bushels of corn to the acre.

In Ripley County the cultivation is much more extended than in Carter County. No towns or stores are to be seen through this section, as all of the trading is done at the stations along the main lines of the railroads, and consequently leaves the river. The distance to these stations is from 15 to 25 miles, the only commerce along the river being the cutting and rafting of pine, oak, ash, and hickory logs, which are mostly floated down to the sawmills at Doniphan.

*Doniphan.*—Doniphan is situated on the river, and is about 41¼ miles below Van Buren. It is the county seat of Ripley County, and is by far the most important town on the river. It is connected with the main line of the St. Louis, Iron Mountain and Southern Railroad by a small branch road, 20 miles long, known as the Doniphan Branch. It is a business town of 1,000 inhabitants, has 1 newspaper, 1 bank, 8 general merchandise stores, 2 hardware stores, 1 furniture store, 3 drug stores, 2 blacksmith shops, 1 machine shop, 3 hotels; 2 sawmills, 2 saw and planing mills, and 2 turning mills, with a combined capacity of 60,000 feet of sawed lumber per day; 1 flour mill, with a capacity of 175 barrels of flour per day. Three hundred carloads of merchandise and groceries were received during this year, which will average 25,000 pounds to the car.

The shipments by railroad were 700 carloads of pine lumber, 200 carloads of oak lumber, 75 carloads of hoop poles, 20 carloads of cedar posts, 225 carloads of ties, averaging 40,000 pounds to the carload; also 100 carloads of live stock and 240 bales of cotton.

The freight rate, first-class, to St. Louis, is 80 cents per hundredweight. During the year 150 rafts of sawed lumber passed Doniphan, going down the river; these rafts will average 20,000 feet of lumber to the raft. No estimate could be obtained of the number of pine, oak, cedar, and hickory log rafts which have passed down the river, but it is estimated that 6,000,000 feet of pine and oak logs have been rafted and run to this point alone. Below Doniphan and to the State line the country is well cultivated and yields good crops of corn, wheat, oats, and cotton, but no definite estimate of total yield could be obtained, as these products are hauled from 15 to 20 miles to the railroads.

*Buffalo Creek.*—Buffalo Creek, 12 miles below Doniphan, is a section of very good and fertile lands. About 6,000 acres adjacent to the river is cultivated, producing about 180,000 bushels of corn and 1,700 bales of cotton.

*Pittmans Landing.*—Pittmans Landing is the head of navigation, although at present the boats do not run regularly on account of the bad condition of the river. There is a large tie and stave trade from this point, but no estimate could be obtained, as the ties and staves are cut and floated down from quite an extended length of river frontage that reaches for miles. The cotton shipments from the country lying between Doniphan and Pittmans Landing and within 5 miles of the river are estimated at 5,000 bales per annum. Below Pittmans Landing is an uninhabited tract of land which has been practically undisturbed except by small portable sawmills and loggers. The stand of timber on this tract is large and of thick growth, mostly of oak and cypress. This land is fertile and strong. Five miles back of this tract are finely cultivated lands growing large crops of cotton and corn.

*Cherokee Bay Country.*—At the mouth of Little Black River is the Cherokee Bay country. This section of land, which is very fertile, produces about 4,000 bales of cotton and 50,000 bushels of corn. The trading and shipping point for this country is at Jim Johnsons, situated about 22 miles above the mouth of Current River. Boats ply to this point all the year round.

*Jim Johnsons.*—Jim Johnsons has about 30 inhabitants, has 2 general merchandise stores, 1 sawmill (capacity 20,000 feet of sawed lumber per day), 1 feed mill and cotton gin. Its imports were chiefly merchandise and groceries, and for 1892 were 150 tons; shipments, 4,000 bales of cotton, 150,000 oak staves, 850,000 feet of lumber, hoop poles, and railroad ties. Near Jim Johnsons are 2 sawmills, one above and one below. They have a combined capacity of 25,000 feet of sawed lumber per day. From this point on down the river banks are dotted with small portable sawmills and logging camps, and there are now in sight about 8,000 cross-ties, 300,000 oak staves, and 2,000,000 feet of oak, pine, cypress, and cedar logs lying along the banks.

Ten million feet of oak, pine, and cypress logs are estimated to have passed Pocahontas this year. The amount is large when it is taken into consideration that the railroads have built a great many branches and tramways through the upper river country and are hauling logs and timber to such points along the main line as Neelyville, Williamsville, and Moark.

Merchants, millmen, and agriculturists who have passed their lives along this river estimate that the improvement of the river so that it would be navigable would increase their trade, agricultural interests, and value of land over three times their present amount and valuation.

Very respectfully, your obedient servant,

A. Walker, Jr.,
*Overseer.*

Capt. H. S. Taber,
*Corps of Engineers, U. S. A.*

# APPENDIX X.

## *REPORTS OF CAPT. S. W. ROESSLER, CORPS OF ENGINEERS, UPON PRELIMINARY EXAMINATIONS OF MEMPHIS HARBOR AND WOLF RIVER TENNESSEE.*

1. **Harbor at Memphis, Tenn., including removal of bar forming opposite the upper part of the city, and bank protection along the city front.**
2. **Wolf River, Tennessee.**

## X 1.

### PRELIMINARY EXAMINATION OF HARBOR AT MEMPHIS, TENN., INCLUDING REMOVAL OF BAR FORMING OPPOSITE THE UPPER PART OF THE CITY, AND BANK PROTECTION ALONG THE CITY FRONT.

UNITED STATES ENGINEER OFFICE,
*Memphis, Tenn., April 8, 1893.*

GENERAL: I have the honor to submit the following report of a preliminary examination made in compliance with the following clause in the river and harbor act of July 13, 1892: "Harbor at Memphis, Tenn., including removal of bar forming opposite the upper part of the city, and bank protection along the city front."

### REMOVAL OF BAR.

In response to a clause in the river and harbor act of September 19, 1890, a preliminary examination of this bar, having the same object in view, was made in 1891, and in my report dated May 16, 1891,* a full description is given of the bar, the causes which led to its formation, and the possible plans of improvement are discussed. I quote as follows from this report:

> The project for the improvement of Memphis Harbor and Memphis Reach, as submitted by Capt. (now Maj.) Miller in 1882, and as approved by the Commission contemplated the revetment of Hopefield Bend from Mound City down, as the rapid caving then in progress, by changing the position and direction of the current, threatened injurious changes in the bed of the river in front of Memphis. The position of Hopefield Point and the shape of the bend above it were, at that time, favorable to the maintenance of the deep-water channel along Memphis front, by

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*See Annual Report Chief of Engineers, 1891, pp. 257 and 3587.

causing the main current to set in to the Tennessee shore at the extreme upper end of the harbor front in the vicinity of the mouth of Wolf River. In fact, so vigorous was the attack of the current at this point, that the same project contemplated repairing and and strenthening the revetment already in place in the vicinity of the mouth of Wolf River and an extension of the revetment upstream to the mouth of Frames Chute. The protection work in Hopefield Bend was commenced in 1882, and beginning at Mound City was extended downstream as rapidly as funds were provided, being finally completed by the extension of the revetment to Hopefield Point in 1888. The long period occupied in the execution of the work was due to the absence of the necessary funds at the proper time, and Hopefield Point, which was the key to the whole situation, was not reached till it had caved back about 3,000 feet from the position in which it should have been held. The bank line, as finally protected, presents a nearly straight course along the lower end, and the main current of the river, following closely the same general direction, has transferred its point of maximum attack from the vicinity of the mouth of Wolf River to the lower end of the paved levee near the foot of Beale street. During the progress of this change in the position and direction of the main river current an eddy action grew up along the upper portion of the harbor, causing the deposit which is the subject of this report.

After describing the growth of the bar during the high water of 1891 the report continues:

Taking into consideration the present position of the zero contour, its uniform curvature and general parallelism to the zero contour of the opposite bank and the form of the protected bank above Hopefield Point, I think the conclusion is evident that the present forces are seeking to establish a new bank line approximately along the same contour, and that the only way in which this tendency can be overcome and a scour effected which will ultimately remove the bar will be by means of deflecting dikes at Hopefield Point.

All the facts in reference to this evil, excepting the result of the last survey, have been presented to and taken under consideration by the Mississippi River Commission. In a special report, dated December 10, 1889, to the president of the Commission, Captain Leach set forth at length the impairment of the harbor facilities of Memphis by the growth of this bar, and presented a project which was designed to ameliorate the evil rather than to cure it. The main features of his project were:

1. To build a training wall or dike 1,500 feet long from the present Mississippi bank, immediately above the mouth of Wolf River, along a suitable curve so as to turn the discharge of Wolf River downstream along the shore.
2. To increase, if necessary, the natural discharge of Wolf River by clearing the banks of its tributary, the Loosa Hatchie, of brushwood and timber and enlarging the section of Sycamore Bayou which connects the Loosa Hatchie with the Mississippi above the head of Old Hen Island.

The conditions existing at that time were sufficient, in the judgment of Captain Leach, to justify the hope of success from this method of treatment, but the aggravated conditions, as they exist at the present time, seriously affect the prospect of even a moderate measure of success under this plan, unless accompanied by a very considerable and indeterminate amount of dredging over a distance of about 4,000 feet from Wolf River down to the lower end of the bar.

In my judgment the situation has narrowed down to the question whether it will be best to permit the formation of a new bank line, which in time would become available for the accomodation of shipping, or to attempt the removal of the entire bar by the construction of deflecting dikes at Hopeful Point. If the latter course, which I recommend for consideration, should be decided on, there is sufficient data on hand without further surveys to prepare a project. The locality is, in my opinion, worthy of improvement.

In his indorsement upon my report General Comstock, supervising engineer, states:

The natural forces at work are now tending to give a new shore line, probably somewhere in the vicinity of the present low-water line. These forces can be counteracted and their results be destroyed in two ways—either by extensive dredging annually repeated, or by works on the Hopefield side, which will force the river back to its former position along the upper part of the Memphis front. Either of these methods will be very costly, especially the latter, and its success is not certain. The river is now so narrow that the bar apparently can not advance much farther. These considerations have prevented the Mississippi River Commission from undertaking any new work at Memphis. Temporary relief up as far as the Anchor Line elevator could be attained by a moderate amount of dredging.

But, using the language of the act, "the removal of the bar forming opposite the upper part of the city or the prevention of the river bank taking the form that the natural forces are now giving it," is, in view of its great cost and uncertain results, in my judgment not a work worthy of being done by the United States.

The survey of 1892 shows an increase in the height and width of the bar over those of the previous year and a further extension downstream of about 400 feet; but with these exceptions the situation created by the presence of the bar is unaltered.

There being no new facts developed that tend to alter the conclusions expressed in the report of May 16, 1891, I have the honor to report, adopting Gen. Comstock's opinion, that deflecting works at Hopefield Point are too costly and uncertain to justify serious consideration, that the removal of the bar is not a work worthy of being done by the United States.

### BANK PROTECTION ALONG THE CITY FRONT.

The portion of the city front referred to by the act is included between the mouth of Wolf River, at the upper end of the city, and the Kansas City and Memphis Railroad Bridge, at the lower end of the city, a distance of about 13,300 feet. Of this 9,500 feet of front is already protected from caving as follows:

From the mouth of Wolf River to the foot of Beale street, a distance of 6,500 feet it is protected by brush and stone mattresses laid at various times between 1878 and 1887.

For a distance of 2,100 feet below Beale street it is protected by the Citizen's dikes, constructed in 1886–87, and for a distance of about 1,000 feet above the bridge it is protected by a continuous mattress of brush and stone, constructed by the bridge company as a protection to its shore pier and abutment. These revetments are believed to be in good condition and in no need of repair. The only piece of bank remaining unprotected is included between the lower end of the Citizen's dikes and the upper end of the bridge company's revetment, and is 3,800 feet long. The caving here is slow but constant, and the protection against any considerable recession of the bank is desirable in order to protect property and valuable land and to prevent the channel from taking an oblique direction to the bridge spans. The bank is a part of the bluff formation upon which the city of Memphis is located, and yields very slowly to the action of the current. As yet it has not caved back far enough behind the revetments above and below it to have any very perceptible influence in changing the direction of the current through the spans of the bridge, but as the caving is gradual from year to year the protection of the bank will sooner or later become necessary, though at present it does not seem immediately urgent.

The improvement is, in my opinion, worthy of being done by the United States. Should a special survey be ordered it can best be done at the same time the annual survey of Memphis Reach is made, during the coming low-water season. No special allotment for such survey will be needed, as the cost of the survey for the reach will be borne by the Commission's allotment for surveys and examinations.

Very respectfully, your obedient servant,

S. W. ROESSLER,
*Captain of Engineers.*

Brig. Gen. THOMAS L. CASEY,
*Chief of Engineers, U. S. A.*

[Second indorsement.]

U. S. ENGINEER OFFICE,
SOUTHWEST DIVISION,
*New York, April 25, 1893.*

Respectfully returned to the Chief of Engineers.

In view of the great cost and the uncertainty of the results of an attempt to remove it, I do not think the removal of the bar at the upper part of the city of Memphis a work worthy of being done by the General Government.

The 3,800 feet of unprotected bank between the Citizens' dikes and the bridge revetment will probably need revetment sooner or later, and is worthy of being done by the General Government. I concur with Capt. Roessler in the opinion that it is not immediately urgent.

C. B. COMSTOCK,
*Colonel of Engineers, Bvt. Brig. Gen., U. S. A.,*
*Division Engineer.*

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## X 2.

## PRELIMINARY EXAMINATION OF WOLF RIVER, TENNESSEE.

UNITED STATES ENGINEER OFFICE,
*Memphis, Tenn., April 11, 1893.*

GENERAL: In compliance with Department letter of July 14, 1892, I have the honor to submit the following report of a preliminary examination of Wolf River, Tennessee, required by the river and harbor act of July 13, 1892.

Wolf River is a small stream in western Tennessee which empties into the Mississippi River just north of the city of Memphis and within the limits of the municipal corporation. It emerges from the bluff lands into the bottom lands of the Mississippi River at a point about 2½ miles from its mouth, and from this point to its junction with the Mississippi it flows through the alluvial formation of the Mississippi Valley. All the navigation which the river has at present or is likely to have in the near future is confined to the lower 2 miles of its course.

The interests that are concerned in Wolf River navigation are the Memphis and Little Rock Railroad Transfer Company, whose terminal on the Memphis side is at the mouth of Wolf River, and the large sawmill interests which line the south bank of Wolf River for a distance of 1½ to 2 miles above its mouth. These interests are considerable. At present the mills represent an investment of $1,500,000, an annual pay roll of $316,000, and an annual business of $1,835,000. The Memphis and Little Rock Railroad Transfer Company have an investment of $100,000, and in 1891 transferred a total of 27,040 cars.

The interests chiefly to be considered are the sawmills and other manufacturers of wood articles, all of which are entirely dependent on unrestricted navigation. Owing to the absence of rail communication on the opposite bank all the mills are located on the south bank, where all the available and desirable sites are occupied. To meet the demand for new sites, a railroad bridge is being constructed across the river about one and one-half miles above its mouth, and when completed new mills will be erected on the north bank. All of these mills draw their supply of logs from the Mississippi River and are vitally dependent on an uninterrupted navigation at all stages of water of the lower 2 miles of Wolf River and through its mouth into deep water of the Mississippi River.

This piece of river is subject to back water from the Mississippi River except at extreme low stages of the latter, and deposits of silt are annually precipitated in its channel. These deposits are regularly removed by the freshets to which Wolf River is liable during local rains. The freshets are often of great violence, especially when the Mississippi is low, and in the past have proved sufficient to maintain a channel of width and depth sufficient for the needs of commerce. A few obstructions, such as sunken logs and piles, render navigation slightly difficult at very low water; but I am informed by those interested that on the whole the channel is in a satisfactory condition. The difficulty lies in the river's mouth through the outlying sand bar. Up to 1889 there was deep water where the bar is now. In that year heavy deposits occurred, and in order to maintain an uninterrupted channel through it the Memphis and Little Rock Railroad Transfer Company dredged a total of twenty-five days at low water. In 1890 they dredged a total of thirty-eight days; in 1891, a total of sixty-six days, and in 1892 a total of only five days. The small amount of dredging required in 1892 was due to the increase in the height of the bar and the greater concentration and scour of the Wolf River discharge through its channel.

I do not anticipate that any dredging will be required this year, as the further increase of the height of the bar during the present flood and the still greater concentration and scour of the Wolf River discharge across it, it is thought, will maintain a depth across the bar fully as great as the depth of the river above its mouth. Should any dredging, however, be required in the future, the work is, in my judgment, worthy of being done by the United States, and I recommend that a survey of Wolf River channel across the bar and of Wolf River proper above its mouth as far as navigation is carried on be made at next low water.

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Very respectfully, your obedient servant,

S. W. ROESSLER,
*Captain of Engineers.*

Brig. Gen. THOMAS L. CASEY,
*Chief of Engineers, U. S. A.*

(Through Col. C. B. Comstock, Corps of Engineers, Division Engineer, Southwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
SOUTHWEST DIVISION,
*New York, April 25, 1893.*

Respectfully forwarded to the Chief of Engineers.

I am of opinion that the mouth of Wolf River is worthy of improvement by the General Government by a moderate amount of dredging.

C. B. COMSTOCK,
*Colonel of Engineers, Bvt. Brig. Gen., U. S. A.,*
*Division Engineer.*

# APPENDIX Y.

## REMOVING SNAGS AND WRECKS FROM MISSISSIPPI RIVER; IMPROVEMENT OF MISSISSIPPI RIVER BETWEEN THE OHIO AND MISSOURI RIVERS, OF HARBOR AT ST. LOUIS, MO., OF GASCONADE AND OSAGE RIVERS, MISSOURI, AND OF KASKASKIA RIVER, ILLINOIS.

### *REPORT OF MAJ. CHAS. J. ALLEN, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1893.*

IMPROVEMENTS.

1. Removing snags and wrecks from Mississippi River.
2. Mississippi River between Ohio and Missouri rivers.
3. Harbor at St. Louis, Mo.
4. Gasconade River, Missouri.
5. Osage River, Missouri.
6. Kaskaskia River, Illinois.

UNITED STATES ENGINEER OFFICE,
*St. Louis, Mo., July 8, 1893.*

GENERAL: I have the honor to transmit herewith the annual reports for the works under my charge for the fiscal year ending June 30, 1893.

Very respectfully, your obedient servant,

CHAS. J. ALLEN,
*Major, Corps of Engineers.*

Brig. Gen. THOMAS L. CASEY,
*Chief of Engineers, U. S. A.*

## Y 1.

## REMOVING SNAGS AND WRECKS FROM MISSISSIPPI RIVER.

Before this work was inaugurated the navigation of the river was very much interfered with by numerous snags, logs, etc., which had lodged in the channel, and to which a new accession was brought down on each rise of the river, thus constantly adding new and unknown obstructions to those already there. A large number of wrecks, dangerous to navigation, also occupied the channel. For the removal of these obstructions appropriations were made as early as 1824, and the project adopted consisted of building boats suitable for removing the snags, etc., and operating them whenever the stage of water was favorable for the work and funds were available.

The total amount expended for this purpose cannot be definitely given, as previous to the appropriation made by act of March 3, 1879, a general amount was appropriated to be applied to several streams as their needs required.

Congress, by act of March 3, 1879, appropriated the first specific sum for removing snags, wrecks, etc., from the Mississippi River, and that appropriation was followed by others until 1888, when, by the act of August 11 of that year, an annual expenditure not to exceed $100,000, for this purpose was authorized. Under that act operations have been carried on annually.

The two snag boats, the *H. G. Wright* and the *J. N. Macomb*, operated during the past fiscal year between the mouth of the Missouri River and New Orleans, La.

The *Wright* began work on August 8 and operated continuously until March 29, last. The *Macomb* began on August 19 and worked until February 14, at which date it was disabled by breakage of the crank pin of the port main engine.

The work accomplished by the two boats is given in the following table:

| Name of snag boat. | Snags pulled. | Trees cut. | Drift piles removed. | Miles run. |
|---|---|---|---|---|
| H. G. Wright | 1,558 | 4,909 | 12 | 10,237 |
| J. N. Macomb | 1,388 | 3,305 | 4 | 7,745 |
| Total | 2,946 | 8,214 | 16 | 17,982 |

The boats were thoroughly overhauled during the spring and necessary repairs made, together with some small renewals of machinery.

Two new capstan engines ordered for the *Wright* were well under way at the close of the year.

The work accomplished by the snag boats is of great benefit to the navigation of the river. Formerly the wrecking of steamboats by running on snags was of frequent occurrence, but since the snag boats have been regularly at work such wrecks are seldom heard of.

An annual appropriation of an amount not to exceed $100,000 having been made for the work, the snag boats will patrol the river whenever necessary in order to keep the channel clear of obstructions.

Amount expended on this work to June 30, 1892, under all specific and annual appropriations, including that of March, 1879, $834,260.77.

Amount expended on the work during the fiscal year ending June 30, 1893, $96,497.23, a detailed statement of which expenditure is given in the accompanying tables Nos. 1 and 2.

*Appropriations made by Congress for removing obstructions in Mississippi River.*

| By act of— | |
|---|---|
| March 3, 1879 | $100,000.00 |
| June 14, 1880 | 100,000.00 |
| March 3, 1881 | 80,000.00 |
| August 2, 1882 | 85,000.00 |
| July 5, 1884* | 72,950.63 |
| August 5, 1886 | 56,250.00 |
| August 11, 1888 | 100,000.00 |

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*This appropriation was for $75,000, $72,950.67 of which was used on this work.

For fiscal year ending—

| | |
|---|---|
| June 30, 1890* | $49,089.17 |
| June 30, 1891 | 92,720.97 |
| June 30, 1892 | 98,250.00 |
| June 30, 1893 | 96,497.23 |
| Total | 930,758.00 |

## *Money statement.*

| | |
|---|---|
| Amount drawn under section 7, act of August 11, 1888 | $96,497.23 |
| June 30, 1893, amount expended during fiscal year | 96,497.23 |
| July 1, 1893, amount available for fiscal year 1893-'94 | 100,000.00 |

Table No. 1.—*Detailed statement of expenditures made in connection with the work of removing obstructions in the Mississippi River during fiscal year 1893, as required by section 7 of the river and harbor act of August 11, 1888.*

| Month. | Voucher. | To whom paid. | For what paid. | Amount. |
|---|---|---|---|---|
| 1892. | | | | |
| July | 1 | N. O. Nelson Manufacturing Co | Supplies | $177.32 |
| | 2 | William Gray | Services | 36.67 |
| Aug | 1 | Hired men | do | 603.00 |
| | 2 | do | do | 1,220.83 |
| | 3 | do | do | 1,213.34 |
| | 4 | Carl Setz | Subsistence | 24.25 |
| | 5 | Francis Whittaker & Sons | do | 18.83 |
| | 6 | John J. Ganahl Lumber Co | Lumber | 24.50 |
| | 7 | Anchor Line Store | Supplies | 39.50 |
| | 8 | M. M. Buck & Co | do | 5.68 |
| | 9 | St. Louis Art Co | do | 3.00 |
| | 10 | O. F. Conklin | Electric-light plant | 1,165.00 |
| | 11 | Alice Armstrong | Services | 65.00 |
| | 12 | Huse & Loomis Ice and Transportation Co | Ice | 146.22 |
| | 13 | Fulton Iron Works | Repairing machinery | 2,300.50 |
| | 14 | Charles Miller, trustee | Covering water tanks | 13.40 |
| | 15 | Pond Engineering Co | Machinery | 35.50 |
| | 16 | Western Anthracite Coal Co | Coal | 11.00 |
| | 17 | Bischoff-Gregg Meat and Vegetable Co | Subsistence | 398.33 |
| | 18 | David Nicholson | do | 86.62 |
| | 19 | Ewald Iron Co | Iron, steel, etc | 99.85 |
| | 20 | N. O. Nelson Manufacturing Co | Supplies | 105.20 |
| | 21 | T. Bradley | Traveling expenses | 24.00 |
| | 22 | J. N. Montgomery | Services | 5.00 |
| | 23 | G. E. Meissner | Subsistence | 30.88 |
| | 24 | St. Louis Post-Office | Postage stamps | 5.00 |
| | 25 | Carl Setz | Subsistence | 9.50 |
| | 26 | Drey & Kahn | Window glass | 2.43 |
| | 27 | Fulton Iron Works | Castings | 18.10 |
| | 28 | Schroeter Bros | Lumber | 13.26 |
| | 29 | Lammert Furniture Co | Outfit | 21.00 |
| | 30 | G. E. Meissner | Subsistence | 35.50 |
| | 31 | Hired men | Services | 603.00 |
| Sept | 1 | C. Weir | Subsistence | 22.20 |
| | 2 | Valentin Resch | do | 4.65 |
| | 3 | Hired men | Services | 234.49 |
| | 4 | Samuel Smith | do | 30.00 |
| | 5 | Hired men | do | 1,485.33 |
| | 6 | do | do | 1,287.67 |
| | 7 | do | do | 802.50 |
| | 8 | Natchez Ice Co | Ice, etc | 15.80 |
| | 9 | C. Pichetto | Subsistence | 9.25 |
| | 10 | Joe Hirsch | do | 40.40 |
| | 11 | Geo. Traub & Co | do | 34.56 |
| | 12 | Matt Monaghan & Co | do | 52.35 |
| | 13 | Peatross, Cameron & Co | Coal | 131.20 |
| | 14 | Pittsburg Coal Co | do | 548.00 |
| | 15 | James A. Tappan | do | 80.00 |
| | 16 | Cairo City Coal Co | do | 24.80 |
| | 17 | Leonard & Ellis | Oil | 2.50 |
| | 18 | James Ward & Son | Supplies and outfit | 315.52 |
| | 19 | David Nicholson | Subsistence | 1,062.42 |
| | 20 | Anchor Line Store | Supplies | 353.71 |

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*Sec. 7, act of August 11, 1888, provides for a yearly appropriation of $100,000, or as much thereof as may be necessary, for the purpose of removing snags, wrecks, and other obstructions from the Mississippi River.

TABLE NO. 1.—*Detailed statement of expenditures made in connection with the work of removing obstructions in the Mississippi River, etc.*—**Continued.**

| Month. | Voucher. | To whom paid. | For what paid. | Amount. |
|---|---|---|---|---|
| 1892. | | | | |
| Sept | 21 | Maj. A. M. Miller | Mileage | $140.96 |
| | 22 | H. C. Wilson | Traveling expenses | 29.56 |
| | 23 | James Sweeney & Son | Copperpipe | 27.00 |
| | 24 | Samuel Cupples Wooden Ware Co | Outfit | 16.23 |
| | 25 | F. U. Hugunin | do | 6.95 |
| | 26 | Rumsey & Sikemeier Co | Steam fittings | 10.64 |
| | 27 | Ripley & Bronson | do | 9.42 |
| | 28 | John J. Ganahl Lumber Co | Lumber | 84.13 |
| | 29 | J. H. Crane | Outfit | 21.00 |
| | 30 | Wrought Iron Range Co | Castings | 12.00 |
| | 31 | Page & Tolkacz | Outfit, etc | 30.63 |
| | 32 | Simmons Hardware Co | Outfit and supplies | 78.67 |
| | 33 | Peterson & Homes | Outfit | 51.15 |
| | 34 | J. Kennard & Sons Carpet Co | Linoleum | 47.18 |
| | 35 | J. J. Streett & Co | Oils, etc | 117.23 |
| | 36 | Excelsior Manufacturing Co | Outfit and castings | 33.95 |
| | 37 | J. S. Merrell Drug Co | Medicines | 17.58 |
| | 38 | Goodyear Rubber Co | Rubberboots | 27.00 |
| | 39 | Day Rubber Co | Supplies | 11.53 |
| | 40 | M. M. Buck & Co | Outfit and supplies | 151.93 |
| | 41 | Chas. W. Barstow | do | 59.02 |
| | 42 | Wm. Barr Dry Goods Co | Outfit | 30.00 |
| | 43 | Robt. D. Patterson Stationery Co | Stationery | 40.29 |
| | 44 | Whitelaw Bros | Paints | 15.70 |
| | 45 | Ewald Iron Co | Iron, steel, etc | 191.79 |
| | 46 | Branch-Crookes Saw Co | Drag saws | 13.70 |
| | 47 | Western Coal and Tow Co | Coal | 337.80 |
| | 48 | E. A. Hitchcock | do | 162.49 |
| | 49 | Huse & Loomis Ice and Transportation Co. | Ice | 116.36 |
| | 50 | Henry A. Koettker | Subsistence | 66.67 |
| | 51 | Elwell & Ward | do | 50.91 |
| | 52 | Francis Whittaker & Sons | do | 328.38 |
| | 53 | Bischoff-Gregg Meat and Vegetable Co | do | 310.40 |
| | 54 | H. C. Wilson | Services | 200.00 |
| | 55 | G. Pantaleoni | Globes | 2.18 |
| Oct | 1 | Hired men | Services | 350.00 |
| | 2 | do | do | 1,717.17 |
| | 3 | do | do | 323.00 |
| | 4 | do | do | 1,797.00 |
| | 5 | do | do | 309.00 |
| | 6 | Jerry Cross | do | 91.00 |
| | 7 | Frank Miller | do | 75.00 |
| | 8 | Valentin Resch | Subsistence | 96.98 |
| | 9 | Jacob Walter | do | 22.19 |
| | 10 | L. S. Koerber | do | 37.17 |
| | 11 | Jessie Hinkle & Co | do | 55.35 |
| | 12 | Natchez Ice Co | Ice | 10.50 |
| | 13 | Peatross, Cameron & Co | Coal | 280.00 |
| | 14 | Pittsburg Coal Co | do | 1,283.76 |
| | 15 | James A. Tappan | do | 240.00 |
| | 16 | J. Hirsch | Subsistence | 76.11 |
| | 17 | Geo. Traub | do | 132.64 |
| | 18 | Francis Whittaker & Sons | do | 268.06 |
| | 19 | Ringen Stove Co | Stoves | 97.45 |
| | 20 | James Ward & Son | Supplies | 33.98 |
| | 21 | Cairo City Coal Co | Coal | 228.25 |
| | 22 | E. A. Hitchcock | do | 194.99 |
| | 23 | Paddock Hawley Iron Co | Iron | 38.80 |
| | 24 | Peterson & Homes | Outfit | 10.85 |
| | 25 | Buxton & Skinner Stationery Co | Stationery | 8.05 |
| | 26 | Page & Tolkacz | Outfit | 3.55 |
| | 27 | M. M. Buck & Co | Tiller rope | 87.13 |
| | 28 | Geo. A. Rubelmann Hardware Co | Outfit and supplies | 10.23 |
| | 29 | Mitchell Furniture Co | Bedsprings, etc | 23.00 |
| | 30 | J. S. Merrell Drug Co | Medicines | 23.58 |
| | 31 | Wm. Z. Howard | Services | 40.00 |
| | 32 | W. A. Bonsack Lumber Co | Lumber | 185.24 |
| | 33 | Elwell & Ward | Subsistence | 41.62 |
| | 34 | Henry A. Koettker | do | 113.41 |
| | 35 | David Nicholson | do | 709.26 |
| | 36 | Branch-Crookes Saw Co | Drag saws | 28.80 |
| | 37 | J. H. Crane | Outfit | 6.70 |
| | 38 | Consolidated Coal Co. of St. Louis | Coal | 197.00 |
| | 39 | Anchor Line Store | Outfit and supplies | 148.69 |
| | 40 | N. O. Nelson Manufacturing Co | do | 88.85 |
| | 41 | Matt Monaghan & Co | Subsistence, etc | 231.59 |
| | 42 | John J. Ganahl Lumber Co | Lumber | 2.00 |
| | 43 | Simmons Hardware Co | Outfit and supplies | 52.36 |
| | 44 | Wrought Iron Range Co | Castings | 6.26 |

**Table No. 1.**—*Detailed statement of expenditures made in connection with the work of removing obstructions in the Mississippi River, etc.*—Continued.

| Month. | Voucher. | To whom paid. | For what paid. | Amount. |
|---|---|---|---|---|
| 1892. | | | | |
| Oct | 45 | Huse & Loomis Ice and Transportation Co | Ice | $23.32 |
| | 46 | Western Coal and Tow Co | Coal | 143.75 |
| | 47 | Bischoff-Gregg Meat and Vegetable Co | Subsistence | 169.16 |
| | 48 | Ewald Iron Co | Iron, steel, etc | 57.85 |
| | 49 | Western Stove Manufacturing Co, | Heating stove, etc | 22.28 |
| | 50 | General Electric Co | Incandescent lamps | 28.00 |
| | 51 | Hired men | Services | 603.00 |
| | 52 | ......do | ......do | 1,655.50 |
| | 53 | ......do | ......do | 476.00 |
| | 54 | Jerry Cross | Services | 50.00 |
| Nov | 1 | Hired men | ......do | 1,810.00 |
| | 2 | ......do | ......do | 343.83 |
| | 3 | Scott Green | ......do | 30.33 |
| | 4 | Francis Whittaker & Sons | Subsistence | 53.44 |
| | 5 | Henry A. Koettker | ......do | 65.85 |
| | 6 | David Nicholson | ......do | 128.18 |
| | 7 | Fred Munz | ......do | 38.98 |
| | 8 | Jacob Walter | ......do | 39.14 |
| | 9 | Matt Monaghan & Co | ......do | 130.50 |
| | 10 | Geo. Traub & Co | ......do | 84.86 |
| | 11 | J. Hirsch | ......do | 40.00 |
| | 12 | C. Weir | ......do | 70.40 |
| | 13 | Natchez Ice Co | ......do | 27.80 |
| | 14 | Consolidated Coal Co. of St. Louis | Coal | 125.20 |
| | 15 | E. A. Hitchcock | ......do | 197.99 |
| | 16 | Cairo City Coal Co | ......do | 51.00 |
| | 17 | Pittsburg Coal Co | ......do | 1,200.00 |
| | 18 | James A. Tappan | ......do | 240.00 |
| | 19 | Peatross, Cameron & Co | ......do | 280.00 |
| | 20 | Goodyear Rubber Co | Rubber boots | 9.00 |
| | 21 | Ripley & Bronson | Supplies | 62.55 |
| | 22 | Branch-Crookes Saw Co | Drag saws | 14.40 |
| | 23 | Fulton Iron Works | Refrigerating machines | 315.00 |
| | 24 | O'Connor & Harder | Castings, etc | 6.60 |
| | 25 | Wm. Barr Dry Goods Co | Outfit | 66.12 |
| | 26 | Ringen Stove Co | Stove fixtures | 3.00 |
| | 27 | Anchor Line Store | Outfit and supplies | 152.15 |
| | 28 | James Ward & Son | Spppplies | 8.29 |
| | 29 | Ewald Iron Co | Iron and steel | 76.98 |
| | 30 | M. M. Buck & Co | Chain and wire | 9.35 |
| | 31 | W. A. Bonsack Lumber Co | Lumber | 76.48 |
| | 32 | Huse & Loomis Ice and Trans. Co | Ice | 38.09 |
| | 33 | Simmons Hardware Co | Outfit and supplies | 13.95 |
| | 34 | Bischoff-Gregg Meat and Vegetable Co | Subsistence | 15.70 |
| | 35 | Hired men | Services | 403.00 |
| Dec | 1 | Jerry Cross | ......do | 50.00 |
| | 2 | Hired men | ......do | 1,747.67 |
| | 3 | ......do | ......do | 396.01 |
| | 4 | ......do | ......do | 1,340.00 |
| | 5 | ......do | ......do | 847.67 |
| | 6 | E. Giardina | Subsistence | 24.05 |
| | 7 | Matt Monaghan & Co | ......do | 200.04 |
| | 8 | Kney, Lidle & Co | ......do | 71.24 |
| | 9 | G. E. Traub | ......do | 56.22 |
| | 10 | Pittsburg Coal Co | Coal | 1,351.04 |
| | 11 | James A. Tappan | ......do | 360.00 |
| | 12 | Parker, Ritter Nichols Stationery Co | Stationery | 2.00 |
| | 13 | N. O. Nelson Manufacturing Co | Supplies | 3.21 |
| | 14 | Consolidated Coal Co. of St. Louis | Coal | 78.40 |
| | 15 | Cairo City Coal Co | ......do | 265.30 |
| | 16 | E. A. Hitchcock | ......do | 121.87 |
| | 17 | M. M. Buck & Co | Lamps | 7.50 |
| | 18 | A. S. Aloe & Co | Thermometer | 7.00 |
| | 19 | Simmons Hardware Co | Outfit and supplies | 8.00 |
| | 20 | Elwell & Ward | Subsistence | 35.10 |
| | 21 | Henry A. Koettker | ......do | 26.45 |
| | 22 | David Nicholson | ......do | 207.32 |
| | 23 | Francis Whittaker & Sons | ......do | 74.98 |
| | 24 | Bischoff-Gregg Meat and Vegetable Co | ......do | 88.70 |
| | 25 | Jacob Walter | ......do | 24.69 |
| | 26 | Oliver-Finnie Grocer Co | ......do | 58.74 |
| | 27 | Charles Jordan | ......do | 64.16 |
| | 28 | J. Hirsh | ......do | 32.38 |
| | 29 | Natchez Ice Co | ......do | 28.50 |
| | 30 | Peatross, Cameron & Co | Coal | 140.00 |
| | 31 | F. Bocler | Covering steam pipes | 83.73 |
| | 32 | Ewald Iron Co | Iron | 10.39 |
| | 33 | Sawyer-Man Electric Co | Incandescent lamps | 53.35 |
| | 34 | Jerry Cross | Services | 50.00 |

**TABLE NO. 1.**—*Detailed statement of expenditures made in connection with the work of removing obstructions in the Mississippi River, etc.*—Continued.

| Month. | Voucher. | To whom paid. | For what paid. | Amount. |
|---|---|---|---|---|
| 1892.<br>Dec. | 35 | Philip Radden | Services | $28.00 |
| | 36 | Hired men | do | 603.00 |
| | 37 | do | do | 1,782.50 |
| | 38 | do | do | 332.00 |
| | 39 | do | do | 1,782.00 |
| | 40 | do | do | 396.00 |
| 1893.<br>Jan. | 1 | H. M. Ehrmann & Bro | Subsistence | 37.04 |
| | 2 | E. A. Hitchcock | Coal | 73.12 |
| | 3 | Anchor line store | Outfit and supplies | 394.35 |
| | 4 | James Ward & Son | do | 790.42 |
| | 5 | David Nicholson | Subsistence | 364.89 |
| | 6 | James A. Tappan | Coal | 340.00 |
| | 7 | Ewald Iron Co | Iron and steel | 37.97 |
| | 8 | Van Nort Bros | Supplies | 11.59 |
| | 9 | Valentin Resch | Subsistence | 27.53 |
| | 10 | Francis Whittaker & Sons | do | 127.25 |
| | 11 | Huse & Loomis Ice and Transportation Co. | Ice | 10.63 |
| | 12 | Cairo City Coal Co | Coal | 267.90 |
| | 13 | Consolidated Coal Co. of St. Louis | do | 115.00 |
| | 14 | Simmons Hardware Co | Outfit and supplies | 81.78 |
| | 15 | Pittsburg Coal Co | Coal | 1,050.00 |
| | 16 | Peatross, Cameron & Co | do | 392.00 |
| | 17 | Geo. Traub | Subsistence | 98.61 |
| | 18 | Chas. Jordan | do | 38.23 |
| | 19 | C. Weir | do | 42.16 |
| | 20 | Natchez Ice Co | do | 2.00 |
| | 21 | Matt Monaghan & Co | do | 125.11 |
| | 22 | Bischoff-Gregg Meat and Vegetable Co | do | 104.18 |
| | 23 | Henry A. Koettker | do | 69.65 |
| | 24 | W. A. Bonsack Lumber Co | Lumber | 124.30 |
| | 25 | M. M. Buck & Co | Supplies | 15.21 |
| | 26 | Page & Tolkacz | Outfit and supplies | 21.80 |
| | 27 | O'Connor & Harder | Castings | 5.50 |
| | 28 | Jacob Walter | Subsistence | 36.53 |
| | 29 | Hired men | Services | 603.00 |
| Feb. | 1 | Maj. A. M. Miller | Mileage | 78.16 |
| | 2 | Western Stove Manufacturing Co. | Castings | 2.25 |
| | 3 | Ben Williams | Subsistence | 17.80 |
| | 4 | Hired men | Services | 1,847.00 |
| | 5 | do | do | 840.00 |
| | 6 | do | do | 1,846.33 |
| | 7 | do | do | 296.67 |
| | 8 | Jerry Cross | do | 50.00 |
| | 9 | Wrought Iron Range Co | Castings | 30.14 |
| | 10 | Southern Express Co | Express charges | 2.65 |
| | 11 | John C. Fowler | Services | 25.00 |
| | 12 | James C. Steger | Subsistence | 28.45 |
| | 13 | Joseph Stokes | Wood | 11.25 |
| | 14 | H. H. Bowen | do | 51.75 |
| | 15 | Wood Bodley & Co. | Coal | 60.00 |
| | 16 | L. S. Koerber | Subsistence | 81.68 |
| | 17 | Pittsburg Coal Co | Coal | 1,845.00 |
| | 18 | James A. Tappan | do | 360.00 |
| | 19 | J. H. Coffin & Co. | Outfit and supplies | 223.55 |
| | 20 | George Traub | Subsistence | 200.78 |
| | 21 | Matt Monaghan & Co | do | 285.76 |
| | 22 | Oliver-Finnie Grocer Co. | do | 606.56 |
| | 23 | Page & Tolkacz | Outfit | 4.50 |
| | 24 | J. Hirsch | Oil and subsistence | 102.61 |
| | 25 | Peatross, Cameron & Co. | Coal | 200.00 |
| | 26 | Natchez Ice Co. | Subsistence | 30.50 |
| | 27 | Hired men | Services | 753.00 |
| March. | 1 | do | do | 893.67 |
| | 2 | do | do | 1,720.00 |
| | 3 | do | do | 240.00 |
| | 4 | do | do | 1,205 00 |
| | 5 | do | do | 69.34 |
| | 6 | E. P. Elliott | do | 40.00 |
| | 13 | Jerry Cross | do | 50.00 |
| | 16 | St. Louis, Iron Mountain and Southern Rwy. Co. | Commutation tickets | 12.25 |
| | 42 | J. Hirsch | Subsistence | 61.49 |
| | 43 | Kney, Lidle & Co | do | 91.40 |
| | 44 | Albert Raine | do | 93.84 |
| | 45 | Berton & Werner | do | 21.00 |
| | 46 | Matt Monaghan & Co. | do | 191.04 |
| | 47 | C. Weir | do | 14.08 |

**Table No. 1.**—*Detailed statement of expenditures made in connection with the work of removing obstructions in the Mississippi River, etc.*—Continued.

| Month. | Voucher. | To whom paid. | For what paid. | Amount. |
|---|---|---|---|---|
| 1893.<br>March. | 48 | Jacob Walter | Subsistence | $55.45 |
| | 49 | Natchez Ice Co | do | 9.00 |
| | 50 | James A. Tappan | Coal | 320.00 |
| | 51 | W. G. Coyle & Co | do | 80.00 |
| | 52 | do | do | 100.00 |
| | 53 | Peatross, Cameron & Co | do | 198.00 |
| | 54 | Cairo City Coal Co | do | 120.00 |
| | 55 | Pittsburg Coal Co | do | 1,440.00 |
| | 56 | The Oliver-Finnie Grocer Co | Subsistence, etc | 273.43 |
| | 57 | Pat. Norton | Repairing furnace | 15.00 |
| | 79 | Jerry Cross | Services | 40.00 |
| | 84 | Hired men | do | 653.00 |
| | 85 | do | do | 207.49 |
| | 86 | do | do | 1,342.50 |
| | 87 | do | do | 1,857.50 |
| | 88 | do | do | 297.84 |
| Apr | 1 | St. Louis, Iron Mountain and Southern Rwy. Co. | Commutation tickets | 24.50 |
| | 11 | Carl Setz | Subsistence | 5.25 |
| | 65 | Huse & Loomis Ice and Transportation Co. | Ice | 35.43 |
| | 66 | The Consolidated Coal Co. of St. Louis | Coal, etc | 331.50 |
| | 67 | Bischoff-Gregg Meat and Vegetable Co | Subsistence | 280.55 |
| | 68 | Fred Munz | do | 8.72 |
| | 69 | Williams & Schevenell | do | 43.86 |
| | 70 | Francis Whittaker & Sons | do | 121.23 |
| | 71 | Elwell & Ward | do | 38.72 |
| | 72 | Matt. Monaghan & Co | do | 48.15 |
| | 73 | David Nicholson | do | 490.74 |
| | 74 | Henry A. Koettker | do | 191.55 |
| | 75 | Anchor Line Store | Zinc, etc | 16.65 |
| | 76 | James Ward & Son | White lead, oils, etc | 369.57 |
| | 77 | Himmelberger & Friant | Sawing logs | 10.00 |
| | 78 | Pittsburg Coal Co | Coal | 240.00 |
| | 79 | Cairo City Coal Co | do | 84.00 |
| | 80 | St. Louis Ore and Steel Co | do | 271.12 |
| | 81 | Eau Claire-St. Louis Lumber Co | Lumber | 22.18 |
| | 91 | Ewald Iron Co | Iron | 159.73 |
| | 92 | N. O. Nelson Manufacturing Co | Steam fittings, etc | 13.93 |
| | 94 | George D. Barnard & Co | Stationery | 147.30 |
| | 97 | Theo. Heirtz & Son | Antifriction metal | 11.59 |
| | 98 | C. Weir | Subsistence | 5.10 |
| May | 2 | Hired men | Services | 553.00 |
| | 3 | do | do | 1,355.16 |
| | 4 | do | do | 119.33 |
| | 5 | do | do | 1,418.00 |
| | 14 | E. E. Furney, assistant engineer | Traveling expenses | 23.45 |
| | 33 | Thomas Buttley | Services | 13.00 |
| | 44 | W. C. Ellis & Son | Repairs | 5.00 |
| | 45 | P. R. Friedel & Co | Lumber | 4.80 |
| | 50 | Jerry Cross | Services | 35.00 |
| | 54 | Oscar Setz | Milk | 15.50 |
| | 55 | Pat. Norton | Repairing furnace | 64.90 |
| | 97 | Helmbacher Forge and Rolling Mills Co | Forgings | 34.75 |
| | 98 | James Sweney & Son | Steam pipe, etc | 272.40 |
| | 99 | Anchor Line Store | Rivets, etc | 9.28 |
| | 100 | James Ward & Son | Candles, etc | 10.30 |
| | 101 | The W. A Bonsack Lumber Co | Lumber | 264.30 |
| | 102 | The Consolidated Coal Co. of St. Louis | Coal | 148.20 |
| | 103 | Kupferle Bros. Manufacturing Co | Pittman brasses, etc | 72.00 |
| | 104 | Ewald Iron Co | Steel, etc | 73.55 |
| | 105 | Fulton Iron Works | Repairs machinery | 673.50 |
| | 106 | Henry A. Koettker | Subsistence | 132.75 |
| | 107 | Elwell & Ward | do | 16.20 |
| | 108 | Bischoff-Gregg Meat and Vegetable Co | do | 221.42 |
| | 109 | National Tube Works Co | Gas pipe | 31.45 |
| | 114 | Simmons Hardware Co | Lace leather | 2.67 |
| | 131 | Hired men | Services | 412.50 |
| | 132 | do | do | 1,420.00 |
| | 133 | do | do | 1,334.50 |
| June | 37 | St. Louis, Iron Mountain and Southern Rwy. | Commutation tickets | 36.75 |
| | 84 | Oscar Setz | Milk | 15.50 |
| | 85 | David Nicholson | Subsistence | 455.90 |
| | 86 | Peter Nicholson & Sons | do | 157.23 |
| | 87 | Peterson & Homes | Queensware, etc | 15.41 |
| | 88 | Hooker-Colville Steam Pump Co | Steam pump | 72.75 |
| | 89 | Anchor Line Store | Supplies | 304.11 |
| | 90 | James Ward & Son | do | 113.10 |
| | 91 | James Sweney & Son | Repairs | 18.50 |
| | 92 | St. Louis Iron and Machine Works | Tiller heads, etc | 56.75 |

TABLE NO. 1.—*Detailed statement of expenditures made in connection with the work of removing obstructions in the Mississippi River, etc.*—Continued.

| Month. | Voucher. | To whom paid. | For what paid. | Amount. |
|---|---|---|---|---|
| 1893.<br>June... | 93 | James Beakey Stove Co | Pans, etc | $14.55 |
| | 94 | N. O. Nelson Manufacturing Co | Packing, etc | 11.69 |
| | 95 | Phœnix Planing Mill Co | Lumber, etc | 230.36 |
| | 96 | Western Anthracite Coal Co | Coal | 17.00 |
| | 97 | Chas. W. Barstow | Oils, etc | 49.35 |
| | 98 | Wm. Barr Dry Goods Co | Dry goods | 42.75 |
| | 99 | Geo. A. Rubermann Hardware Co | Ax, clamps, etc | 5.67 |
| | 100 | St. Louis Electrical Supply Co | Carbons | 12.00 |
| | 101 | N. M. Simonds | Boilers, pans, etc | 12.45 |
| | 102 | The W. A. Bonsock Lumber Co | Lumber | 131.99 |
| | 103 | Hired men | Services | 1,367.41 |
| | 104 | ......do | ......do | 1,420.00 |
| | 105 | ......do | ......do | 475.00 |
| | 118 | Henry A. Koettker | Subsistence | 162.33 |
| | 119 | ......do | ......do | 121.87 |
| | 120 | ......do | ......do | 88.21 |
| | 121 | Gust. Bischoff | ......do | 470.59 |
| | 122 | Elwell & Ward | ......do | 25.70 |
| | 123 | Carl Setz | Milk | 15.00 |
| | 124 | John J. Ganahl Lumber Co | Lumber | 83.78 |
| | 125 | Huse & Loomis Ice and Transportation Co. | Ice | 127.50 |
| | 126 | Fulton Iron Works | Capstan engines, etc | 1,430.00 |
| | 127 | ......do | Capstan plates | 14.20 |
| | 128 | Alfred C. Kemper | Magnesia covering | 24.10 |
| | 129 | Ripley & Bronson | Valves, etc | 37.07 |
| | 130 | ......do | Rivets | 6.91 |
| | 131 | M. M. Buck & Co | Iron, tools, etc | 98.50 |
| | 132 | Simmons Hardware Co | Pantry ware, tools, etc | 69.29 |
| | 133 | Sam'l Cupples Woodenware Co | Rope, etc | 196.00 |
| | 134 | Ewald Iron Co | Iron and steel | 46.42 |
| | 135 | Fairbanks, Morse & Co | Spice mills, etc | 4.82 |
| | 136 | South St. Louis Foundry | Thrust shafts, etc | 350.00 |
| | | Total | | 96,497.23 |

TABLE NO. 2.—*Summary of expenditures for operating United States snag boats H. G. Wright and J. N. Macomb, in connection with the work of removing obstructions in Mississippi River, during fiscal year ending June 30, 1893.*

| Expenditures. | 1892. | | | | |
|---|---|---|---|---|---|
| | July. | August. | September. | October. | November. |
| Office expenses | | $811.00 | $229.55 | $553.00 | $203.00 |
| Supervision | | 400.00 | 140.96 | 400.00 | 200.00 |
| Expenses of snag boat H. G. Wright: | | | | | |
| Crew | $36.67 | 1,194.83 | 2,120.17 | 2,181.00 | 2,184.16 |
| Outfit | | 21.00 | 119.89 | 138.19 | 474.44 |
| Fuel | | | 1,022.68 | 973.08 | 1,042.82 |
| Subsistence | | 355.23 | 882.78 | 957.58 | 513.47 |
| Supplies | | 27.90 | 201.77 | 320.93 | 211.00 |
| Repairs | 13.39 | 128.39 | 161.31 | 107.32 | 78.48 |
| Miscellaneous | | | 20.29 | 27.83 | |
| Expenses of snag boat J. N. Macomb: | | | | | |
| Crew | | 1,283.34 | 1,719.82 | 4,211.67 | |
| Outfit | | 3,484.58 | 447.39 | 175.79 | |
| Fuel | | | 261.61 | 1,463.92 | 1,035.37 |
| Subsistence | | 394.90 | 1,229.07 | 964.53 | 215.21 |
| Supplies | | 11.00 | 329.81 | 127.74 | 3.00 |
| Repairs | 163.93 | 184.55 | 473.39 | 144.45 | 69.15 |
| Miscellaneous | | 24.00 | 37.58 | 4.90 | |
| Store boat Abert | | 35.00 | | 141.09 | |
| Total | 213.99 | 8,355.72 | 9,398.07 | 12,892.92 | 6,230.10 |

TABLE NO. 2.—*Summary of expenditures for operating United States snag boats H. G. Wright and J. N. Macomb, etc.*—Continued.

| Expenditures. | 1892. | 1893. | | |
|---|---|---|---|---|
| | December. | January. | February. | March. |
| Office expenses | $605.00 | $603.00 | $753.00 | $653.00 |
| Supervision | | | 78.16 | 12.25 |
| Expenses of snag boat H. G. Wright: | | | | |
| Crew | 4,365.67 | | 2,212 00 | 2,465.85 |
| Outfit | 14.00 | 207.54 | 72.62 | |
| Fuel | 1,266.54 | 915.12 | 1,168.00 | 1,172.00 |
| Subsistence | 357.44 | 843.41 | 503.14 | 616.88 |
| Supplies | 9.22 | 191.93 | 130.46 | 8.55 |
| Repairs | | 224.94 | 51.19 | 15.00 |
| Miscellaneous | | | 2.65 | |
| Expenses of snag boat J. N. Macomb: | | | | |
| Crew | 4,286.18 | | 2,142.00 | 5,407.49 |
| Outfit | 7.50 | 717.14 | | |
| Fuel | 1,050.07 | 1,322.90 | 1,177.80 | 1,086.00 |
| Subsistence | 625.90 | 240.40 | 1,027.12 | 185.27 |
| Supplies, | 61.39 | 88.37 | .25 | |
| Repairs | 87.94 | 3.00 | 12.00 | |
| Miscellaneous | 2.35 | | | |
| Store boat Abert | 100.00 | | 50.00 | 90.00 |
| Total | 12,839.21 | 5,357.75 | 9,380.39 | 11,712.29 |

| Expenditures. | 1893. | | | Total. |
|---|---|---|---|---|
| | April. | May. | June. | |
| Office expenses | $147.30 | $565.50 | $275.00 | $5,898.35 |
| Supervision | 24.50 | 423.45 | 236.75 | 1,916.07 |
| Expenses of snag boat H. G. Wright: | | | | |
| Crew | | 2,821.99 | 1,367.41 | 20,949.75 |
| Outfit | 11.75 | | 1,713.23 | 2,772.66 |
| Fuel | 784.37 | 60.00 | | 8,404.61 |
| Subsistence | 577.75 | 185.81 | 791.24 | 6,584.73 |
| Supplies | 105.60 | 6.80 | 215.64 | 1,429.80 |
| Repairs | 147.55 | 478.00 | 726.29 | 2,131.86 |
| Miscellaneous | | | 3.25 | 54.02 |
| Expenses of snag boat J. N. Macomb: | | | | |
| Crew | | 2,838.00 | 1,420.00 | 23,308.50 |
| Outfit | 7.05 | | 236.02 | 5,075.47 |
| Fuel | 140.25 | 88.20 | 17.00 | 7,643.12 |
| Subsistence | 656.12 | 200.06 | 818.59 | 6,587.17 |
| Supplies | 101.73 | 2.67 | 197.43 | 923.39 |
| Repairs | 265.40 | 1,031.43 | 360.66 | 2,795.90 |
| Miscellaneous | 2.00 | | | 70.83 |
| Store boat Abert | | 35.00 | | 451.00 |
| Total | 2,971.37 | 8,736.91 | 8,408.51 | 96,497.23 |

## Y 2.

## IMPROVEMENT OF MISSISSIPPI RIVER BETWEEN OHIO AND MISSOURI RIVERS.

The object of the improvement is to obtain a minimum depth at standard low water of 6 feet from the mouth of the Missouri River to St. Louis, a distance of 16 miles, and of 8 feet at the same stage of water from St. Louis to the mouth of the Ohio River, 191 miles, the natural depth being, in many cases, from 3½ to 4 feet. The channel is divided at a number of points by islands forming sloughs and secondary channels behind them through which a good deal of the volume of flow is diverted to the detriment of navigation.

The initial point of the work for the lower portion is St. Louis, the programme being to make the work continuous, proceeding downstream from that city.

The first work for improvement began in 1872 and was continued for a number of years as appropriations were made, the works consisting of dikes and dams of brush and stone, erected with a view to confining the low-water volume to one channel, and of revetments to hold and preserve the banks where necessary or advisable.

The present project is a continuation of the plan adopted in 1881, and contemplates a reduction of the river to an approximate width of 2,500 feet below St. Louis, the natural width being in many cases from 1 to 1½ miles, and protection of the alluvial banks from erosion. The methods employed are the building up of new banks from the solid matter brought down by the river and which is collected by means of hurdles and revetment of the banks, both new and old, when necessary.

At the beginning of the fiscal year the work for improvement had extended to a distance of about 5 miles below the head of Rush Tower Reach, but the construction at a number of points had been left incomplete as to number and extent of works, in order to observe the effect of the hurdles as built. Considerable damage from floods, ice, and driftwood had been sustained, and some new banks formed by the hurdles required revetment to secure their permanency.

During the fiscal year new work was prosecuted at a number of points, and as far as Turkey Island, 42 miles below St. Louis, and extensions and repairs were also made, all as given below:

### TWIN HOLLOWS, WEST SIDE, 5 MILES BELOW ST. LOUIS.

Work of constructing additional hurdles began at this point on May 27, last.

One hurdle (No. 5½), 362 feet long, was built, and another (No. 7) was partly built by the close of the year. Please see Pl. No. 2.

### PULLTIGHT.

This locality is nearly opposite Twin Hollows. The work of repairing and extending the system began March 27 and continued until April 30, when, on account of extreme high water, it was suspended and force and plant were removed to Rush Tower Reach. Afterward, May 21, the force and plant which had been engaged on the Fort Chartres Reach was brought to Pulltight to complete the work at that point.

The work done at Pulltight consisted in repairing Hurdle No. 4, in extending it 630 feet, and in driving about 400 linear feet of drift clumps above the old part of this hurdle to protect it; also in repairing Hurdle No. 5, and restoring it to its original length; also, in repairing Hurdle No. 2, and extending it 1,200 feet to the original channel limit, and in extension of Hurdle No. 1, and construction of 1,500 linear feet of new work of Hurdle No. 6. Please see Pl. No. 2.

The completion of Hurdles 1 and 6, and curtaining all the hurdles except No. 2, remained at the close of the year to be done.

### CHESLEY ISLAND, 11 MILES BELOW ST. LOUIS.

The bank protection at this point was repaired. This was done during the first half of the fiscal year. The location is shown on Pl. No. 2.

### RUSH TOWER REACH, 28 MILES BELOW ST. LOUIS.

During the fiscal year, operations consisted in the construction of 6,800 linear feet of bank protection of the Illinois shore from a point near the Osborne field to the lower end of the wooded bank just above Durfee's Landing. This work was begun August 10 and finished November 26. About 1,225 feet of bank along Lowry's field was partially revetted. Three hundred linear feet of Hurdle No. 3, at Michael's were repaired. Construction of Hurdles 3 and 6 was begun at Fish Bend, May 1, and work on them continued to May 31. One thousand four hundred and fifty linear feet of Hurdle 3 were nearly completed and 365 feet of Hurdle 6 partly completed. The location of these works is shown on Pl. No. 3.

### FORT CHARTRES REACH, 35 MILES BELOW ST. LOUIS.

This reach extends from Brickey Mill to the head of Turkey Island. The work projected for its improvement includes protection of the left bank of the river below Sycamore Landing, and construction of a series of hurdles to close the chute west of Bruce Island; also a series of hurdles above the head of Turkey Island.

The work of the year consisted in protection of the bank, below medium stage of water, from Sycamore Landing, downstream, for a distance of 5,500 feet, and the building of Hurdles 2 and 3, having a total length of 3,525 feet, on the west side of Bruce Island. These hurdles were considerably damaged upon the breaking up of the ice in the latter part of February, and subsequently by heavy fields of driftwood.

As soon as possible, in March, following the break-up, the work of repairing these hurdles was undertaken, and was continued until about the middle of May, when, on account of the high stage of water, work on the hurdles was temporarily suspended.

The location of the work is shown on Pl. No. 4.

All the above work was done by hired labor.

### PROCURING MATERIALS.

The brush was procured by hired labor.

Of the stone, 8,670.10 cubic yards were purchased upon bids in open market, and 20,584.13 cubic yards were quarried by hired labor.

Piles were procured partly by contract and partly by purchase in open market.

Rope, bolts, wire, spikes, nails, etc., were purchased by contract when large quantities were needed; otherwise, in open market.

At the beginning of the fiscal year the available plant was insufficient for carrying on the work under the appropriation made by the river and harbor act of July 13, 1892, and large additions were provided for by contracts entered into last fall. These contracts provided for construction and delivery of 1 towboat, 2 steam tenders, 13 model barges, 6 quarter boats, 21 pile-driver hulls and cabins (8 for new drivers and 13 to replace those worn out), 103 flats, and 60 skiffs. All of this plant excepting the towboat were to have been delivered on or before May 1. The towboat was to have been delivered June 1. But owing to various causes the delivery, that of the skiffs excepted, has not yet been completed.

Proposals were also invited for construction of three office and survey boats.

Please see abstracts of proposals, hereto appended.

Parts of new plant not provided for by contract were prepared and minor repairs made by hired labor and purchase of material in open market.

In order to better prosecute work under the appropriation of $658,333.33, made by the act of March 3, 1893, proposals to be opened July 17, 1893, have been invited for construction and delivery of additional plant.

## PLATES.

Plate 1 is a general map of the river from Bissells Point to Kaskaskia Island. Plate No. 2 shows the river from Carrolls Island to Chesley Island. Plate No. 3, from Calico Island to Penitentiary Point; and Plate 4, from Brickey Mill to White Sand Depot.

## SUPPLY DEPOT.

All supplies, excepting stone, brush, and piles, and some minor items, were delivered at the depot at the foot of Arsenal street, St. Louis. In addition the depot is a general repair shop and yard, where repairs to plant not requiring dockage were made.

## VALUE OF PROPERTY.

The present value of the property belonging to this work is shown in the following table:

| Class of property. | Value July 1, 1892. | Purchases, additions, and repairs. | Expenses and deterioration charged to works of improvement. | Value June 30, 1893. |
|---|---|---|---|---|
| Steamer General Gilmore | $12,727.94 | $21,647.84 | $23,503.80 | $10,871.98 |
| Steam launches | 5,466.62 | 688.65 | 1,572.90 | 4,582.37 |
| Steam tenders | | 10,060.38 | | 10,060.38 |
| Barges, model | 78,299.35 | 25,051.38 | 26,666.22 | 76,684.51 |
| Barges, with quarters | 13,716.81 | 8,105.75 | 4,655.75 | 17,166.81 |
| Quarter boats | | 1,733.33 | | 1,783.33 |
| Pile-drivers | 32,893.68 | 13,606.73 | 14,966.86 | 31,533.55 |
| Machine shop | 2,399.51 | 34.25 | 490.16 | 1,943.60 |
| Derrick boat | | 1,500.00 | | 1,500.00 |
| Small boats | 9,663.97 | 13,593.44 | 10,987.42 | 12,269.99 |
| Portable quarters | 6,154.65 | 3,224.24 | 2,327.71 | 7,051.18 |
| Tents | 190.75 | | | 190.75 |
| Supply depot | 3,441.00 | 965.65 | 1,301.15 | 3,105.50 |
| Tools and appliances | 3,032.56 | 6,756.99 | 3,054.76 | 6,734.79 |
| Boarding outfit | 9,314.31 | 5,518.55 | 2,930.90 | 11,896.96 |
| Office furniture | 385.63 | 143.20 | 77.56 | 451.27 |
| Survey instruments | 613.70 | 81.75 | 61.37 | 634.08 |
| Photographic apparatus | 230.16 | 50.00 | 23.02 | 257.14 |
| Total | 178,530.64 | 112,757.18 | 92,619.58 | 198,668.19 |

## GAUGES.

The eight gauges established during the fiscal year ending June 30, 1892, between Jefferson Barracks and Jones Point, were read daily. These gauges were established with a view of determining, from their readings, whether any change in slope of the water surface results from the works of improvement.

### DETAILS OF THE WORK.

For full details of the work done, reference is made to the reports, herewith, of Mr. D. M. Currie, principal assistant engineer, and Messrs. W. S. Mitchell, John O. Holman, and Gerald Bagnall, assistant engineers.

The operations at the supply depot are given in full in the report, herewith, of Mr. C. D. Lamb, superintendent.

### CONDITION OF THE RIVER.

A statement of channel depths, as furnished by the Mississippi and Ohio Rivers Pilots' Society, is herewith.

The river was closed to navigation by ice from December 21, 1892, to February 19, 1893. The stage of water was lowest in November, when 1 foot above standard low water was reached. During the period of lowest water a channel depth of 4 feet was found at two crossings in portions of the river where the works for improvement had not been entirely completed.

There were two high-water seasons. The first in July, when the river reached a height of 31$\frac{1}{10}$ feet above extreme low water, and the other in May, when it reached a height of about 31½ feet above the same stage.

The river has not yet subsided sufficiently to show the effect of the recent high water, but it is probable that large deposits have been made behind the hurdles, and that a much improved channel will result during the coming low-water season wherever works have been constructed.

In general, the works for improvement have benefited navigation. They extend for a distance of 45 miles below the southerly limit of St. Louis, from which point the distances to the several localities and reaches reported upon are given.

### STATISTICS.

Tables of statistics of the commerce of the river are hereto appended. These, as well as the statistics for other works of improvement, were compiled by Mr. Elliott Jones, chief clerk.

### ESTIMATE.

The amount that can be profitably expended during the year ending June 30, 1895, is $758,333.33, which is the sum estimated in the last Annual Report for the fiscal year ending June 30, 1894. It is proposed to expend this sum in carrying out the programme heretofore adopted; that is, to carry on the work of improvement continuously from St. Louis downstream, reclaiming land by building up new banks, thus reducing the river to an approximate width of 2,500 feet, alluvial banks to be protected from erosion. It is proposed to obtain by this means a channel of at least 8 feet at low water. The depth is now liable to become as small as 4 feet or even less in some places, and less at every locality where the width is more than 2,500 feet.

This general statement of the proposed application of the appropriation is as specific as the nature of the case admits. The changeable character of the river renders it impracticable to give in advance the exact locality where works will be required.

The original estimated cost of this improvement of the river between the mouth of the Ohio and the mouth of the Missouri River, as revised in 1883, is $16,397,500.

The aggregate amount from appropriations available for this work, to June 30, 1893, is $5,388,333.33.

Amount expended to June 30, 1892, is $4,080,803.15. Amount expended during fiscal year ending June 30, 1893, is $283,767.17.

The balance available will be expended in prosecuting work according to the programme.

The appropriations made for this work are as follows:

| By act of— | | By act of— | |
|---|---|---|---|
| June 10, 1872 | $100,000.00 | August 2, 1882 | $600,000.00 |
| March 3, 1873 | 200,000.00 | July 5, 1884 | 520,000.00 |
| June 23, 1874 | 200,000.00 | August 5, 1886 | 375,000.00 |
| March 3, 1875 | 200,000.00 | August 11, 1888 | 300,000.00 |
| August 14, 1876 | 200,000.00 | September 19, 1890 | 400,000.00 |
| June 18, 1878 | 240,000.00 | July 13, 1892 | 525,000.00 |
| March 3, 1879 | 200,000.00 | March 3, 1893 | 658,333.33 |
| June 14, 1880 | 250,000.00 | | |
| March 3, 1881 | 600,000.00 | Total | 5,568,333.33 |

Of these amounts, $180,000 was allotted by acts and projects for improvement between the Illinois and Missouri rivers, including Alton Harbor, leaving amount applicable for general improvement between the mouth of the Ohio and Missouri rivers, $5,388,333.33.

*Money statement.*

| | | |
|---|---|---|
| July 1, 1892, balance unexpended | | $124,196.85 |
| Amount appropriated by act approved July 13, 1892 | | 525,000.00 |
| Amount appropriated by sundry civil act approved March 3, 1893 | | 658,333.33 |
| | | 1,307,530.18 |
| June 30, 1893, amount expended during fiscal year | | 283,767.17 |
| July 1, 1893, balance unexpended | | 1,023,763.01 |
| July 1, 1893, outstanding liabilities | $30,565.40 | |
| July 1, 1893, amount covered by uncompleted contracts | 149,295.24 | |
| | | 179,860.64 |
| July 1, 1893, balance available | | 843,902.37 |
| Amount (estimated) required for completion of existing project | | 11,009,166.67 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895 | | 758,333.33 |
| Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893. | | |

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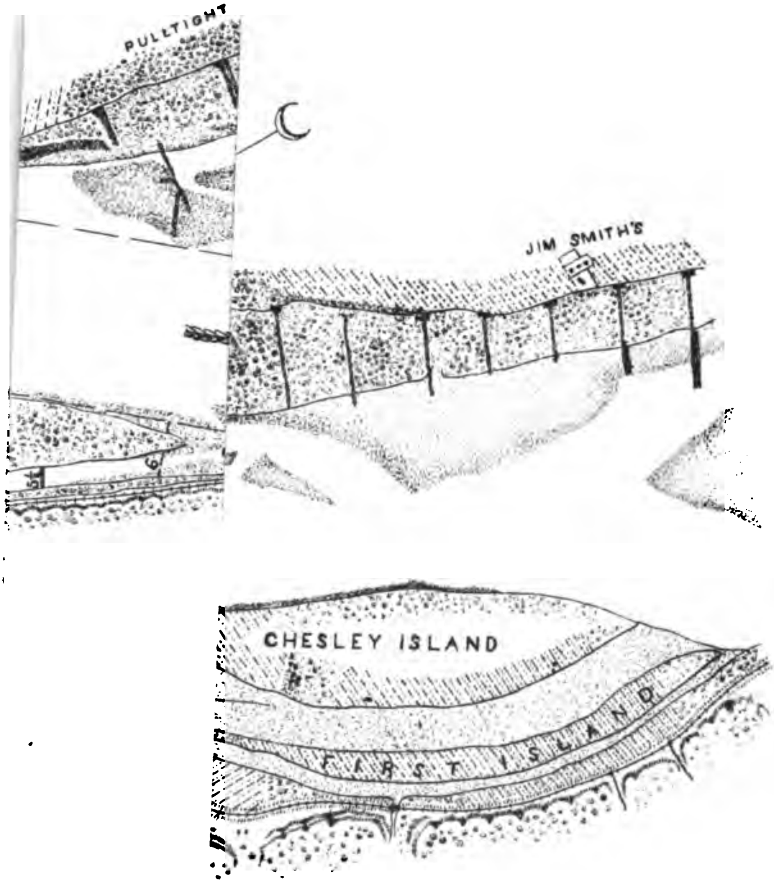
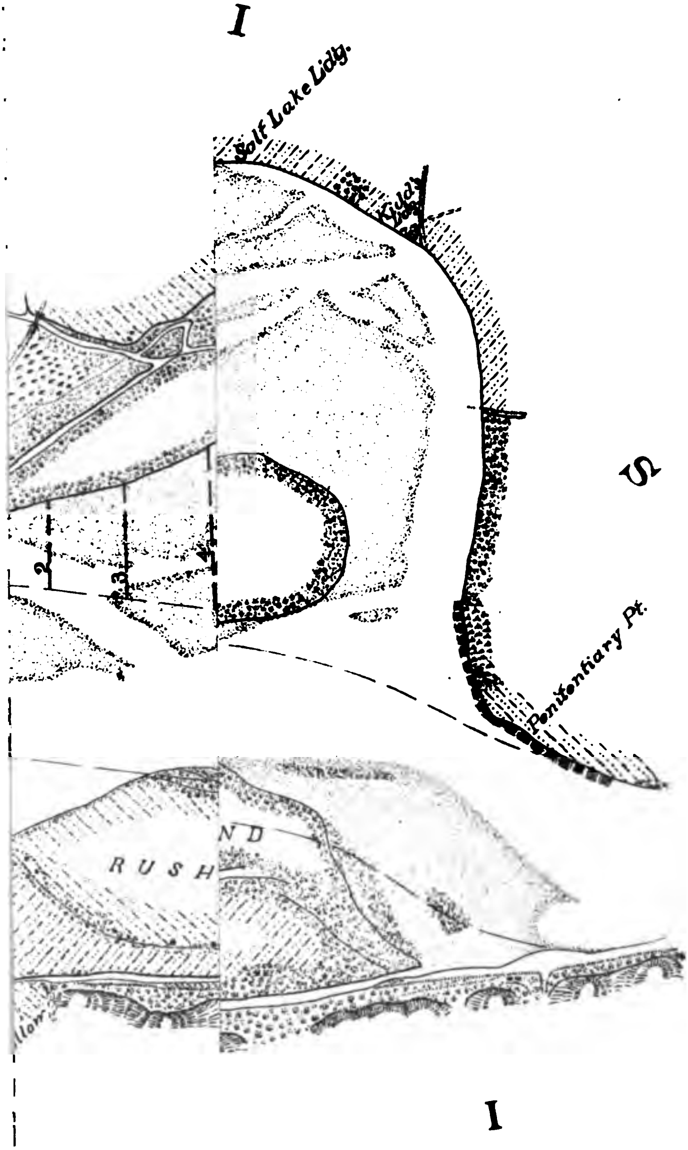
Plate 2.



y MAJOR ALLEN'S ANNUAL REPORT JUNE 30, 1893.

Plate 3



JOR ALLEN'S ANNUAL REPORT JUNE 30, 1893.

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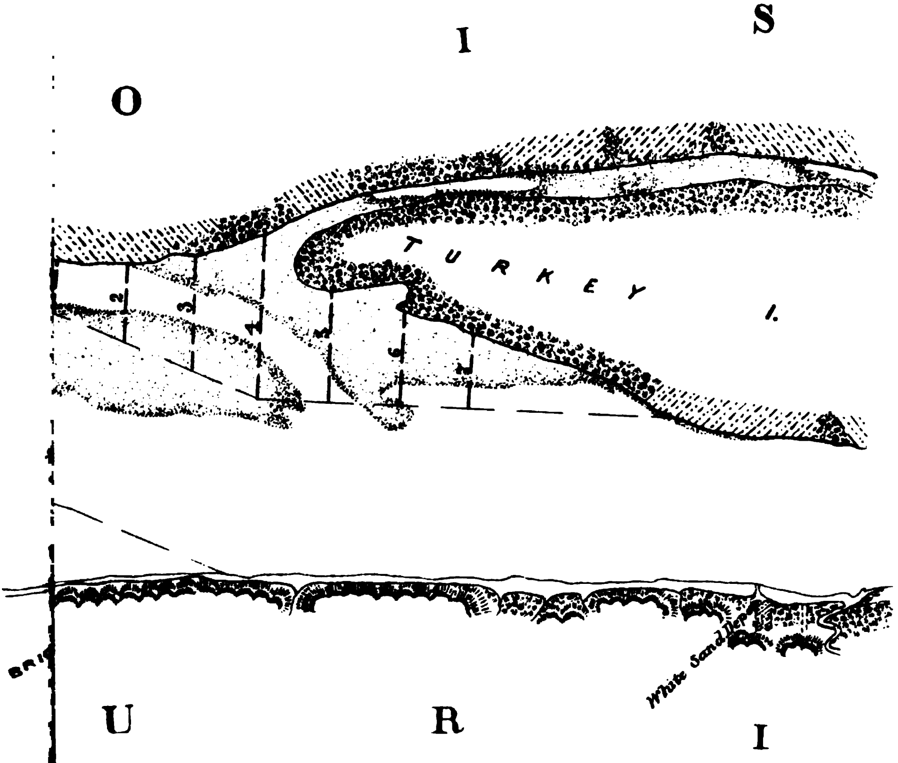
**Plate 4.**



g 93 *To accompany Major Allen's annual report June 30, 1893*

*Abstract of proposals received for furnishing piles, manila and sisal rope, wire, nails, spikes, and screw bolts, opened October 10, 1892, by Maj. A. M. Miller, Corps of Engineers, U. S. Army, St. Louis, Mo.*

| | |
|---|---|
| Balance available | $500,000.00 |
| Total estimated amount, according to awards | 25,027.45 |

| No. of proposal. | Piles | 500 | 1,800 | 2,100 | 1,800 | 1,000 | 800 | 8,000 |
|---|---|---|---|---|---|---|---|---|
| | Name and address of bidder. | 25 to 30 feet long, 14,000 feet—price per foot. | 31 to 35 feet long, 60,800 feet—price per foot. | 36 to 40 feet long, 80,850 feet—price per foot. | 41 to 45 feet long, 78,300 feet—price per foot. | 46 to 50 feet long, 48,500 feet—price per foot. | 51 to 60 feet long, 44,800 feet—price per foot. | Amount. |
| | | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | |
| 1 | Whitney Gilbreath, Ava, Ill | 6 | 6½ | 7 | 7½ | 8 | 8½ | $23,979.50 |
| 2 | John Cleary, Chester, Ill | 5 | 6 | 6½ | 7 | 7½ | 7¾ | 22,051.75 |
| 3 | William G. Allison and Sebastian Oliver, Chester, Ill | 6 | 6½ | 7 | 7½ | 8 | 8½ | 23,979.50 |
| 4 | John W. Reno, New Madrid, Mo | 6 | 6 | 6 | 5¾ | 5¾ | 5½ | 19,064.00 |

| No. of proposal. | Name and address of bidder. | Manila rope (30,000 pounds.) | | Sisal rope (8,000 pounds). | | Wire (20,000 pounds). | | Nails (20,000 pounds). | |
|---|---|---|---|---|---|---|---|---|---|
| | | Price per pound. | Amount. | Price per pound. | Amount. | Price per pound. | Amount. | Price per pound. | Amount. |
| | | *Cents.* | | *Cents.* | | *Cents.* | | *Cents.* | |
| 5 | S. C. Forsaith Machine Co., Manchester, N. H | 12.65 | $3,795.00 | 8.95 | $716.00 | 4.85 | $970.00 | ........ | ........ |
| 6 | Thos. S. Maxwell, St. Louis, Mo | 11.19 | 3,357.00 | *8.12<br>†7.63 | 620.20 | ........ | ........ | ........ | ........ |
| 7 | Anchor Line Store, St. Louis, Mo | 11.75 | 3,525.00 | ........ | ........ | ........ | ........ | ........ | ........ |
| 8 | James Ward & Son, St. Louis, Mo | 12.10 | 3,630.00 | 8.69 | 695.20 | ........ | ........ | ........ | ........ |
| 9 | James J. Hawk, St. Louis, Mo | 11.14 | 3,342.00 | 7.74 | 619.20 | 2.55 | 510.00 | ........ | ........ |
| 11 | M. M. Buck & Co., St. Louis, Mo | 13.00 | 3,900.00 | 10.00 | 800.00 | 3.25 | 650.00 | 2.19 | $438.00 |
| 13 | St. Louis Wire Mill Co., St. Louis, Mo | ........ | ........ | ........ | ........ | 2.50 | 500.00 | ........ | ........ |

* For ⅝-inch rope. † For ½-inch and ¾-inch rope.

| No. of proposal. | Names and address of bidder. | Spikes (17,500 pounds). | | Screw bolts (5,000). | | Remarks. |
|---|---|---|---|---|---|---|
| | | Price per pound. | Amount. | Price per pound. | Amount. | |
| | | *Cents.* | | *Cents.* | | |
| 2 | John Cleary, Chester, Ill | ........ | ........ | ........ | ........ | Slight informality in proposal. |
| 3 | William G. Allison and Sebastian Oliver, Chester, Ill. | ........ | ........ | ........ | ........ | Do |
| 4 | John W. Reno, New Madrid, Mo | ........ | ........ | ........ | ........ | Do. |
| 5 | S. C. Forsaith Machine Co., Manchester, N. H. | ........ | ........ | ........ | ........ | Do. |
| 6 | Thos. S. Maxwell, St. Louis, Mo | ........ | ........ | ........ | ........ | Do. |
| 7 | Anchor Line Store, St. Louis, Mo | 2.73 | $477.75 | ........ | ........ | Do. |
| 10 | Fred. Meyer, St. Louis, Mo | ........ | ........ | 2.50 | $637.50 | Do. |
| 11 | M. M. Buck & Co., St. Louis, Mo | 3.30 | 577.50 | 2.88 | 734.40 | |
| 12 | James B. Dunkerely, St. Louis, Mo. | ........ | ........ | 2.30 | 586.50 | Do. |

No. 2.—Guarantee not signed.

Nos. 3, 5, 7, and 12.—One witness to guarantee.

No. 4.—Erasure and change in price to 5¾ cents, fourth item of piles; made and explained before opening.

No. 6.—Erasure and change in prices of sisal rope; made and explained before opening.

No. 10.—Guarantee not signed in proper place; no witness to guarantee; no jurisdiction of grantors.

*Abstract of proposals received for furnishing 1 towboat, 2 steam tenders, 6 quarter boats, 13 barges, 21 pile-driver hulls and cabins, 103 flats, and 60 skiffs, opened November 7, 1892, by Maj. A. M. Miller, Corps of Engineers, U. S. Army, St. Louis, Mo.*

| | |
|---|---|
| Balance available | $450,000.00 |
| Amount according to awards | 171,481.50 |

| Number of proposal. | Name and address of bidder. | One towboat. | Two steam tenders. | | Six quarter boats. | | |
|---|---|---|---|---|---|---|---|
| | | Price. | Price for each. | Amount. | Number proposed to furnish. | Price for each. | Amount. |
| 5 | Ed. J. Howard, Jeffersonville, Ind. | $21,750.00 | $8,945.00 | $17,890.00 | 3 | $6,575.00 | $19,725.00 |
| 9 | Sam'l W. Coflin & Son, Cincinnati, Ohio | 22,264.00 | 9,747.00 | 19,494.00 | 6 | 5,200.00 | 31,200.00 |
| 10 | The Frisbie Engine and Machine Co., Cincinnati, Ohio | 22,078.00 | 10,168.00 | 20,336.00 | 6 | 5,800.00 | 34,800.00 |
| 11 | M. A. Sweeney Co., Jeffersonville, Ind | 21,450.00 | 4,980.00 | 9,960.00 | ...... | ...... | ...... |
| 13 | Luther M. Emerson, St. Louis, Mo. | ...... | ...... | ...... | 6 | 8,975.00 | 53,850.00 |

| Number of proposal. | Name and address of bidder. | Thirteen barges. | | | Tweny-one pile driver hulls, etc. | | |
|---|---|---|---|---|---|---|---|
| | | Number proposed to furnish. | Price for each. | Amount. | Number proposed to furnish. | Price for each. | Amount. |
| 1 | S. M. Flesher, Levanna, Ohio | 6 | $4,375.00 | $26,250.00 | ...... | ...... | ...... |
| 5 | Ed. J. Howard, Jeffersonville, Ind. | 4 | 4,150.00 | 16,600.00 | 10 | $2,545.00 | $25,450.00 |
| 8 | Clements Bros., Paducah, Ky | 6 | 3,700.00 | 22,200.00 | 10 | 2,400.00 | 24,000.00 |
| 9 | Sam'l W. Coflin & Son, Cincinnati, Ohio | 13 | 3,847.00 | 50,011.00 | 21 | 1,494.00 | 31,374.00 |
| 11 | M. A. Sweeney Co., Jeffersonville, Ind | ...... | ...... | ...... | 21 | 1,640.00 | 34,440.00 |
| 12 | Louis H. Skinner, Wilmington, N. C. | ...... | ...... | ...... | 21 | 1,561.61 | 32,793.81 |
| 13 | Luther M. Emerson, St. Louis, Mo. | ...... | ...... | ...... | 6 | 3,000.00 | 18,000.00 |

| Number of proposal. | Name and address of bidder. | Fifty-three large size decked flats. | | | Forty small size decked flats. | | |
|---|---|---|---|---|---|---|---|
| | | Number proposed to furnish. | Price for each. | Amount. | Number proposed to furnish. | Price for each. | Amount. |
| 2 | Thomas G. Isherwood, Davenport, Iowa | ...... | ...... | ...... | 40 | $130.00 | $5,200.00 |
| 3 | L. Cramer & Son, Parkersburg, W. Va | 53 | $385.00 | $20,405.00 | 40 | 282.00 | 11,280.00 |
| 4 | David S. Barmore, Madison, Ind. | 53 | 674.26 | 35,735.78 | ...... | ...... | ...... |
| 9 | Sam'l W. Coflin & Son, Cincinnati, Ohio | 53 | 415.00 | 21,995.00 | 40 | 213.00 | 8,520.00 |
| 11 | M. A. Sweeney Co., Jeffersonville, Ind | 53 | 496.00 | 26,288.00 | 40 | 346.00 | 13,840.00 |
| 12 | Louis H. Skinner, Wilmington, N. C | 53 | 336.50 | 17,834.50 | 40 | 189.75 | 7,590.00 |

*Abstract of proposals received for furnishing 1 towboat, 2 steam tenders, 6 quarter boats, 13 barges, 21 pile-driver hulls and cabins, 103 flats, and 60 skiffs, etc.*—Continued.

| Number of proposal. | Name and address of bidder. | Ten open flats. | | | Sixty skiffs. | | |
|---|---|---|---|---|---|---|---|
| | | Number proposed to furnish. | Price for each. | Amount. | Number proposed to furnish. | Price for each. | Amount. |
| 2 | Thomas G. Isherwood, Davenport, Iowa | 10 | $95.00 | $950.00 | | | |
| 3 | L. Cramer & Son, Parkersburg, W. Va | 10 | 240.00 | 2,400.00 | | | |
| 6 | T. H. Truscott & Sons, St. Joseph, Mich | | | | 60 | $28.40 | $1,704.00 |
| 7 | James P. Simms, St. Louis, Mo | | | | { 6<br>{ 24 | 85.00 }<br>38.00 } | 1,122.00 |
| 9 | Sam'l W. Coflin & Son, Cincinnati, Ohio | 10 | 124.00 | 1,240.00 | 60 | 39.00 | 2,340.00 |
| 11 | M. A. Sweeney Co., Jeffersonville, Ind | 10 | 296.00 | 2,960.00 | | | |
| 12 | Louis H. Skinner, Wilmington, N. C | 10 | 129.59 | 1,295.90 | | | |

No. 2.—Rejected account of substitution of different kind of material from that required.
No. 7.—No guaranty to proposal.

### AWARDS.

| | |
|---|---|
| Proposal No. 6.—T. H. Truscott & Sons: | |
| 60 skiffs, at $20.40 each | $1,704.00 |
| Proposal No. 8.—Clements Bros: | |
| 6 barges, at $3,700 each | 22,200.00 |
| Proposal No. 9.—S. W. Coflin & Son: | |
| 6 quarter boats, at $5.200 each | 31,200.00 |
| 7 barges, at $3,847 each | 26,929.00 |
| 21 pile-drivers, at $1.494 each | 31,374.00 |
| 10 open flats, at $124 each | 1,240.00 |
| Proposal No. 11.—M. A. Sweeney Co.: | |
| 1 tow boat, at | 21,450.00 |
| 2 steam tenders, at $4,980 each | 9,960.00 |
| Proposal No. 12.—Louis H. Skinner: | |
| 53 large decked flats, at $336.50 each | 17,834.50 |
| 40 small decked flats, at $189.75 each | 7,590.00 |

*Abstract of proposals for three office and survey boats, received in response to advertisement dated April 11, 1893, and opened May 11, 1893, by Maj. Charles J. Allen, Corps of Engineers, at St. Louis, Mo.*

| No. | Name and address of bidder. | Price. | Amount. |
|---|---|---|---|
| 1 | Thomas P. Morse, South St. Louis, Mo | $6,048.70 | $18,146.10 |
| 2 | Louis H. Skinner, Wilmington, N. C | 4,890.30 | 14,670.90 |
| 3 | Diamond Jo Line Steamers, Dubuque, Iowa | 4,400.00 | 13,200.00 |
| 4 | Ed. J. Howard, Jeffersonville, Ind | 5,000.00 | 15,000.00 |
| 5 | David S. Barmore, Madison, Ind | 4,920.00 | 14,760.00 |
| 6 | Weigel Brothers & Co., Elizabeth, Pa | 4,950.00 | 14,850.00 |

Available $256,254.40, from appropriation of July 13, 1892.
No. 3, lowest; acceptance recommended.

## REPORT OF MR. D. M. CURRIE, ASSISTANT ENGINEER.

ST. LOUIS, MO., *June 30, 1893.*

MAJOR: I have the honor respectfully to submit the following report upon the improvement of the Mississippi River between the Ohio and the Missouri rivers, for the fiscal year ending June 30, 1893, including as part of it the accompanying reports of assistants in local charge:

Work was prosecuted at Twin Hollows, Pulltight, Chesley Island, and on both sides of the river at Rush Tower and at Fort Chartres, in accordance with the general plan of improvement adopted to secure a minimum depth of 8 feet at standard low water by reducing the average width to 2,500 feet, and protecting the banks to maintain that width permanently, beginning at St. Louis and extending continuously downstream.

At the beginning of this fiscal year the improvement had been extended to Rush Tower, but the work at several points had been left unfinished to await developments, considerable damage from floods, ice, and driftwood had been sustained, and new banks formed by the works needed protection to secure their permanency. All of these required further work to complete the improvement, but only that portion of it necessary to repair damages sustained as stated can be considered as duplication of the work. The additions and extensions found necessary after sufficient time had been allowed for developments, were contemplated in the several projects of improvement. The works prosecuted during this year at Twin Hollows, Pulltight, and Chesley Island were partly in repairs and partly in extensions and additions necessary to complete original projects. At Rush Tower, that on the west side was in repairs, while that on the east side at this locality and on both sides at Fort Chartres, were in extension of the improvement downstream.

The condition of the works constructed since the adoption of the plan of improvement to obtain the desired results by means of permeable system of hurdles to build up new banks in wide reaches and the protection of the banks to secure the permanency of the results in connection with this year's operations, shows the advance made in the prosecution of the improvement beginning at the head of Arsenal Island and proceeding in their regular order downstream.

*Arsenal Island and Cahokia Chute.*—Cahokia Chute was closed first by a stone dam built to the stage of 2 feet above standard low water prior to the adoption of the permeable system, and afterwards by hurdles to the stage of 16 feet above same plane. At higher stages a small stream of water still finds an outlet through the chute.

In connection with the closing of the chute, the west face of the island was protected to the top of the bank near its head, but on the lower part only to the medium stage, or about 15 feet above low water. This medium-stage protection has been damaged by the erosion of the bank during higher stages of several years, but chiefly during the long flood stage of 1892.

No work was done at this locality during the fiscal year just closed.

*Horsetail Bar.*—In this reach, extending from the River Des Peres to the head of Carrolls Island, nothing has been done since 1884, when all of the work was completed with exception of the protection of the new banks. On the east side several depressions in bars give outlets to small streams of water during high stages and some erosion has occurred on the lower end of the reach. On the west side the protection needs extension to the lower end of the new bank.

*Head of Carrolls Island to Jim Smith's.*—(Divided for purposes of administration into Carroll Island, Twin Hollows east and west, Pulltight, and Beards Island.)

The work in this reach was begun during the fiscal year 1881-'82 upon a project which included a series of works on the west side extending down to the foot of Fine's Bluff, the protection of the bank on the east side from the foot of Carrolls Island to Pulltight landing, afterwards known as Pulltight, and a series of hurdles from that point to include one behind Beards Island followed down stream by the protection of the west bank of Beards Island. During that and succeeding years to include the fiscal year ending June 30, 1884, the bank protection and hurdles on the east side were completed and the series of hurdles on the west side was extended down to include No. 5, as shown on plate No. 2, when on account of a persistent effort of the channel to make a crossing to the west bank at a point near the mouth of White House Creek, the project was revised in 1888, and the Pulltight hurdles, Nos. 1, 2, and 4, were extended and No. 5 was built, when work was again suspeded to await developments. During low-water seasons the depth has been very small in the channel crossing to the west bank near White House Creek, while hurdles No. 1, 2, 4, and 5, Pulltight, were seriously damaged by ice, driftwood, and floods, and further work was projected during this fiscal year having for its object the reduction of the reach from the head of Carrolls Island to Jim Smith's to an average width of 2,500 feet to secure a minimum depth of not less than 8 feet at standard low water. This included hurdles on the west side of

Carrolls Island, the protection of new bank, repairs to hurdles No. 2 to 5, inclusive, and the construction of additional hurdles at Twin Hollows, and the repairs and extention of hurdles No. 1 to 5, inclusive, and the construction of No. 6 at Pulltight (for the location and extent of all these reference is made to plate No. 2).

For administration, the work done during the year has been divided into two sections, known as Twin Hollows and Pulltight.

During last low-water season, the depth at Twin Hollows was only 6 feet, and at Pulltight 4½ feet, and was less than found on any other bars within the reach from St. Louis to Brickey Mill, which had been partly improved.

*Twin Hollows.*—Continued high water during the spring of this year added to the insufficiency of available plant and the urgency of other work delayed the beginning of work at this locality until the last half of May. New hurdles, Nos. 5½, 6, and 7 were built as shown on plate No. 2, and the work was progressing under favorable conditions of weather, stage of river, and increased plant at the close of the fiscal year.

For quantities of work done, and further details, reference is made to the accompanying port of Mr. Gerald Bagnall, Assistant Engineer, in local charge.

*Pulltight.*—At this locality work was begun at the opening of the spring season, was prosecuted until the end of April, suspended on account of excessive difficulties in constructing in the great depths and swift currents consequent upon the high stage of river resumed about the middle of May, and continued to the close of the year at a rate of progress which increased with the improved conditions of weather, stages of river, and facilities for its prosecution. Hurdles Nos. 1, 2, 4, and 5, were repaired and extended, and No. 6 was in process of construction as shown on plate No. 2.

Reference is made for details and quantities of work to the accompanying report of Mr. W. S. Mitchell, Assistant Engineer, in local charge.

*Chesley Island.*—The bank protection placed below medium stage of river on the east side of Chesley Island during the fiscal years 1882-'83, and 1883-'84 was considerably damaged by erosion above it, the hurdle closing Meramec River was also damaged during the long flood stage which prevailed from about the first of May to the middle of July. This protection was repaired during the fiscal year just closed and upon a part of the Island the protection was extended to the top of the bank. The work was done during the first half of the fiscal year, under the supervision of Mr. C. D. Lamb, Assistant Engineer, to whose report reference is made for further details. Its location is shown on plate No. 2.

*Jim Smith's.*—This work was begun in 1882, and prosecuted through to 1885, in accordance with the plans adopted in the original project, which contemplated a series of hurdles on each side of the river to reduce its width to 2,500 feet, but before that portion on the west side could be built the channel changed and crossed to the west bank, below the foot of Chesley Island, instead of to Waters Point, and upon a revised project hurdles on the east side were extended to reduce the river to the average width of 2,500 feet.

At high stages a small channel remains open through the hurdles, near their eastern ends.

A short section of the bank between hurdles Nos. 0 and 1, has been protected.

No work was done during the fiscal year.

*Sulphur Springs.*—The work in this locality was begun in 1886-1887 and a series of hurdles was built extending from the foot of Jim Smiths to the head of Fosters Island. Some of the hurdles have been seriously damaged by ice, driftwood, and floods, and several small streams remain open through them at high stages.

No work has been done during this fiscal year.

*Fosters Island.*—The protection to the medium stage of the west bank of Fosters Island was placed during the years 1882 to 1884 and has been damaged by the erosion of the bank above during the flood stages, notably during that of 1892.

No work was done during this fiscal year.

*Lucas.*—The construction of hurdles in this reach, which extends from the foot of Fosters Island to the head of Calico Island, was begun in 1888 and continued to the close of the fiscal year ending June 30, 1890. Hurdles were built as shown on plate No. 1, and the construction of others was deferred to await developments. The upper one has been seriously damaged by ice, driftwood, and floods; others have sustained some injuries.

No work was done during this fiscal year.

*Rush Tower.*—In this reach, which extends from the head of Calico Island to Brickey Mill, are included several detached works, the protection of the west side of Calico Island, hurdles on the east side near James' Landing, hurdles on the west side below Kennet's Castle, bank protection from Osborne Field to Durfee's Landing, and hurdles below Durfee's, upon all of which works have been prosecuted under the projects for the expenditure of appropriations approved September 19, 1890, and July 13, 1892, and other works were indicated in outline in the chute cutting off Fish Bend when developments shall have reached a stage which will give an average width of 2,500 feet to the channel through the chute.

During this fiscal year works were prosecuted for repairs of Hurdle No. 3, on the west side, below Kennet's Castle. The protection of the bank below medium stages between Osborne Field and Durfee's Landing, and on the construction of hurdles Nos. 3 and 6, of the series projected below Durfee's.

For location of these works, reference is made to plate No. 3, and for quantities of work done and further details to the accompanying report of Mr. John O. Holman, assistant engineer, in local charge.

*Fort Chartres.*—This reach, extending from Brickey Mill to the head of Turkey Island, includes the protection of bank below Sycamore Landing and a series of hurdles to close the chute west of Bruce Island, upon which work was done under the project for the expenditure of the appropriation approved July 13, 1892. A series of hurdles was also indicated in the same project above the head of Turkey Island, upon which work has been deferred until funds become available from future appropriations.

The work of this fiscal year placed a protection upon the bank below medium stages of river from Sycamore landing to a distance of 5,500 feet downstream, built hurdles Nos. 2 and 3 on the west side of Bruce Island and partly repaired the same after they were considerably damaged by ice upon the breaking up of the gorges formed during the winter and subsequently by heavy fields of driftwood which accumulated and were carried over them by the high water of March and April. On account of excessive difficulties encountered there during the high stages of river work was suspended on these hurdles about the middle of May.

The location of these works is shown on plate No. 4, and further details in the accompanying report of Mr. W. S. Mitchell, assistant engineer, in local charge.

## PROCURING MATERIAL.

*Brush.*—The necessary quantity of brush was procured by hired labor and the payment of royalty.

The accompanying report of Mr. C. D. Lamb shows details.

*Stone.*—Of the necessary quantity of stone, 8,670.10 cubic yards were purchased upon bids in open market, and the remainder, 20,584.15 cubic yards, were procured by hired labor and the payment of royalty.

Reference is made to the report of Mr. W. S. Mitchell, assistant engineer, for details relating to the stone procured by hired labor.

*Piles.*—Were procured by contract and by purchase in open market. Other material, including rope, wire, spikes, nails, and bolts, were procured by contract and by purchase upon bids in open market.

*Plant.*—At the beginning of the year the available plant was not sufficient for the expenditure of the appropriation made by the river and harbor bill approved July 13, 1892, and large additions were provided for by contracts, in which were included a towboat, 2 steam tenders, 13 model barges, 6 quarter boats, 21 pile-driver hulls and cabins (8 for new drivers and 13 for repairs), 3 office and survey boats, 103 flats, and 60 skiffs, but for several causes the delivery has not been completed.

Parts of the new plant, now provided for by contract, were prepared, and minor repairs to available plant were made by hired labor and the purchase of material in open market.

Very respectfully, your obedient servant,

D. M. CURRIE,
*Assistant Engineer.*

Maj. CHAS. J. ALLEN,
*Corps of Engineers, U. S. A.*

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## REPORT OF MR. GERALD BAGNALL, ASSISTANT ENGINEER.

### *On work at Twin Hollows.*

TWIN HOLLOWS, WEST, *June 30, 1893.*

MAJOR: I have the honor to make the following report of operations at Twin Hollows, west side, for the fiscal year ending June 30, 1893.

Work was commenced on Hurdle No. 5¼ on May 27 and continued until June 30. This line crosses the chute between the Missouri shore and Twin Hollow tow-head, and has a width of 362 feet. The hurdle consists of a row of clumps of piles, 12 feet apart, driven through a foundation mattress 85 feet wide; each clump is composed of 4 piles, driven 6 feet apart, and drawn together and bolted at the heads with 1-inch bolts. Above the hurdle line, at a distance of about 100 feet, a row of anchor clumps was driven, to which the mattress was attached while being sunk. Shore mats were constructed in place on both shore ends of hurdle, and small extra mats were sunk, where necessary, to prevent scour. A large quantity of drift came down the chute during the progress of the work and made it necessary to sink the foundation mattress in three sections, but the greater portion of it lodged above the anchor clumps and remained there until the completion of the hurdle, when it was pulled down as needed and sunk in layers, one on top of the other, forming a loose dam, each layer overlapping the one below it on the upstream side.

On June 23 hurdle line No. 7 was commenced and continued until June 30, the method of construction being practically the same as that followed in the case of Hurdle No. 5½.

The extent and location of work done is shown on the accompanying tracing.

*Table of work done.*

| | Hurdle line. | | |
|---|---|---|---|
| | No. 5½. | No. 6. | No. 7. |
| Piles driven....number.. | 148 | 13 | 129 |
| Foundation mattress constructed....square feet.. | 58,424 | ....... | 53,375 |
| Shore mattress constructed....do.... | 6,000 | ....... | 6,800 |
| Drift mattress constructed....do.... | 51,690 | ....... | ........ |
| Bank revetted....do.... | 1,000 | ....... | ........ |
| Bank graded....cubic yards.. | 500 | ....... | ........ |

Very respectfully, your obedient servant,

GERALD BAGNALL,
*Assistant Engineer.*

Maj. CHAS. J. ALLEN,
*Corps of Engineers, U. S. A.*

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### REPORT OF MR. WILLIAM S. MITCHELL, ASSISTANT ENGINEER, ON WORK AT PULLTIGHT, ILL.

ST. LOUIS, MO., *June 30, 1893.*

MAJOR: I have the honor to submit the following report upon the progress of the works at Pulltight, Ill., during the fiscal year ending June 30, 1893.

There was no work done during the fall, but late in March a force was organized by Mr. Holman for the repair of the hurdles and their restoration to the east channel limit in this reach.

The party arrived March 27 and was engaged until April 30, when, on account of extreme high water, work here was suspended and the force and plant were removed to Rush Tower, Ill. Afterwards, May 21, the force which had been engaged at Fort Chartres works was brought to Pulltight to complete the project for this locality.

Work was begun March 27 on hurdle No. 4, which was repaired and restored for 630 feet with both foundation mattress and piling, restoring it to its full length. In addition, about 400 linear feet of drift clumps were driven above the old work to protect it.

At the end of April three small breaks, each about 100 feet in length, were made in the line by drift and scour. They were not closed, because of the high water, until the latter part of May, when the line received the few repairs needed.

Hurdle No. 5 was repaired and restored to its former length in April, the work done being about 1,700 feet in length, and included a new foundation mattress 65 feet in width, extending 15 feet above the piling and 50 feet below it.

After the passage of the high water the few necessary repairs were made to the piling across the slough next Beards Island.

In May and June hurdle No. 2 was repaired and restored for 1,200 feet to the channel limit on a line running upstream from the old hurdle and at right angles to that limit. The foundation mattress was 100 feet in width, woven continuously and sunk from anchor piles 100 feet above it. The mattress was held in place during fabrication and sinking by three-quarter-inch wire anchor cables made fast to the piling at the river bottom.

The anchor piles were spaced about 25 feet apart and the cables were released as rapidly as the mattress was sunk, and were used again. After sinking the mattress the piling for the hurdle was driven through its center in 4 pile clumps spaced 10 feet apart and drawn together at the tops by 16-strand wire cables.

The line was completed, including wattling or screening with brush curtains, which were brought to the level of the 20-foot and 10-foot stages on the old and new work, respectively.

Until the latter part of June the water was too deep to undertake the restoration of hurdle No. 1, and the old piling was so nearly submerged that repairs could not be made, but by that time the river had fallen to a 22-foot stage and the work was begun, the force and plant used being moved to this hurdle as rapidly as it was released from No. 2.

The line of the extension is 900 feet in length and parallel to that in No. 2, at right angles with the channel.

At the close of the year 700 linear feet of this new work and the repairs to the old piling were completed.

In character the new work is similar to that described as done on hurdle No. 2.

About the middle of June hurdle No. 6 was begun 3,700 feet below No. 5. It is 1,500 feet in length, and except at the outer end is in shoal water. It is intended to close the small slough next the island and to fix in direction the channel past the upper hurdles. For 850 feet it consists of a single row of piles driven through a mattress 65 feet wide 15 feet from its upper edge. From that point the mattress is in deep water and is 100 feet wide; 100 linear feet have been fabricated, and the piling which is to be driven along its center line has been begun.

Between the piling and the timber line the island bank has been protected with a mattress and stone revetment.

The completion of lines Nos. 1 and 6 and curtaining all the hurdles except No. 2 remain to be done at the close of the year.

The accompanying chart shows the location of the work done, the condition of the hurdles, and the depths found throughout the reach. The tables show the service of plant and the amounts of material expended.

Very respectfully, your obedient servant,

WM. S. MITCHELL,
*Assistant Engineer.*

Maj. CHAS. J. ALLEN,
*Corps of Engineers, U. S. A.*

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## REPORT OF MR. JOHN O. HOLMAN, ASSISTANT ENGINEER, ON WORK AT RUSH TOWER.

ST. LOUIS, MO., *June 30, 1893.*

MAJOR: I have the honor to submit herewith the following report of operations at Rush Tower for the fiscal year ending June 30, 1893.

The work consisted of bank protection on the Illinois shore, the repair of hurdle No. 3 at Michaels, and the construction of hurdles Nos. 3 and 6 at Fish Bend.

### BANK PROTECTION.

*Table of work done.*

| | No. of linear feet. | No. of square feet. |
|---|---|---|
| Mattress | 6,800 | 816,000 |
| Revetment | 6,800 | 146,325 |
| Grading | 1,225 | *3,100 |

* Cubic yards.

The bank protection extends from the middle of the timber below the Osborne field to the lower end of the wooded bank just above Durfee's Landing, a distance of 6,800 feet. The working season covered a period of 103 days, from August 10 to November 26. The mattress was built in 86 days—an average of 79 feet per day, or 92 feet excluding Sundays. The maximum rate of construction was made in the last week of October, when a rate of 145 feet was maintained during the six working days.

The mattress was built to the usual width of 120 feet, with its inner edge, when placed, resting on the bank at the water surface, which varied during the construction of the mattress from the 12 to the 5 foot stage. Cables about one-half inch in diameter were used to strengthen the river edge of the mattress. From one to four were used, according to the strength of the current.

The head of the mattress, station 0, was placed at the foot of the shore bar, which extends up river to the hurdles above. Its construction proceeded without interruption to station 16, when the steamer *Monroe* ran over it just above the mooring barge, breaking the outer portion of the mattress. A day's time was lost in sinking the broken portion into its position and replacing the weaving flats ready for construction.

The next difficulty occurred at station 60. The four cables, which had been used along the strong current from station 50, parted, but whether by breaking or through improper fastening could not be ascertained. The loss of mattress amounted to 70 feet.

The bank along Lowry's field was graded for a length of 1,225 feet between station 2+75 and 15 to a slope of 2 to 1, but only a small portion of it was revetted to the top of the bank. Riprap was placed above the mattress to the foot of the bluff bank. The widths of the revetment and the stage to which it was carried is given in the following table:

| Stations. | Widths. | Stage |
|---|---|---|
| 0 to 2+75 | 29 | 14 |
| 2+75 to 4 | 54 | 26 |
| 4 to 10 | 26 | 14 |
| 10 to 17 | 12 | 10 |
| 17 to 24 | 10 | 9 |
| 24 to 42 | 35 | 13 |
| 42 to 50 | 20 | 11 |
| 50 to 68 | 12 | 8 |

HURDLES.

*Table of work done.*

| | Michael's No. 3. | Rush Tower. | |
|---|---|---|---|
| | | No. 3. | No. 6. |
| Length constructed ... feet | 300 | 1,450 | 365 |
| Piles driven ... number | 212 | 600 | 96 |
| Stringers placed ... do | 38 | 23 | ........ |
| Mattress ... linear feet | 640 | 1,450 | 365 |
| Mattress ... square feet | 38,960 | 145,000 | 36,500 |

*Michael's No. 3 hurdle.*—During the progress of the protection work on the Illinois shore a small force was engaged in closing the gap at the shore end of No. 3 hurdle.

Across the gap, 300 feet in length, piles were driven in two rows 20 feet apart, the rows composed of three pile clumps well supported with stringers and cross stringers between. The foundation mattress was 285 feet long by 60 feet wide.

Above the upper row of clumps 260 cords of old brush was spread which was covered with a drift mattress averaging 52 feet in width and then sunk to the bottom. This mattress, 355 feet in length, reached from the shore dike to the bar at the end of the old hurdle. The shore dike, 210 feet long, joins the end of the hurdle. It was raised to the 12-foot stage, in which work 3,300 cubic yards of riprap was used. The remainder of the old brush on hand, 160 cords, was used in the construction of a mattress which connected with the shore dike and extended 130 feet into the hurdle. Its width was 18 feet and its depth 7, with its upper edge at the 5-foot stage when placed. The space between the mattress and the clumps of the upper row was filled with riprap.

*Fish Bend, Nos. 3 and 6 hurdles.*—These hurdles were built in the spring season, May 1 to 31. The form used in their construction differs somewhat from that previously adopted. In the method used the mattress was built 100 feet in width, held in position during its construction by lines to a row of clumps 150 feet above, driven only for the purpose of holding the mattress. The hurdle piles were driven in two rows 6 to 8 feet apart through the middle of the mattress with the piles in these rows pulled together in clumps of four piles.

In shoal water a stringer was placed on the piles in the upper row with a brace pile driven under each one.

On No. 3 hurdle 1,450 linear feet of mattress was constructed, the same length of clump row above, and 1,150 feet of hurdle row was driven. After the mattress at the shore end was placed some of the piles in the clump row were pulled and redriven in the hurdle row, but the pile timber thus recovered was not a compensation for the labor expended.

On No. 6 hurdle the clump row was driven across the chute and 365 linear feet of mattress constructed, 230 at the tow head and 135 feet at the Illinois end. The hurdle was left in an unfinished condition, as the plant was required for work at Twin Hollow, where it was transferred at the close of May.

Very respectfully, your obedient servant,

JOHN O. HOLMAN,
*Assistant Engineer.*

MAJ. CHAS. J. ALLEN,
*Corps of Engineers, U. S. A.*

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## REPORT OF MR. C. D. LAMB, ASSISTANT ENGINEER, ON WORK AT CHESLEY ISLAND.

ST. LOUIS, MO., *June 30, 1893.*

MAJOR: I have the honor to submit the following report of operations at Chesley Island during the fiscal year ending June 30, 1893:

The protection on the east side of Chesley Island built during 1882 and 1883 remained in good condition until the last high water, when the bank was cut away inside the old work in several places. An examination made early in October showed that a semicircular cave 140 feet in diameter had been made just inside the head of the island, the bank above a 10-foot stage had been cut away from station 5+25 to 8+70, and also from station 27+75 to the lower end of the revetment at station 43+30. From station 3+50 to 6+90, and from 36+45 to the foot of the work the bank was cut away between the mattress and revetment, a trough having an average width of 35 feet being scooped out by the current to a depth of 10 feet.

The needed repairs were begun on the 11th of October near the upper end of the work; sections of mattresses 40 feet wide were built on flats from brush cut on the island, and placed in the spaces between the mattress and the revetment; the cave at the head of the island was graded and revetted, the revetment was repaired and extended to the top of the bank down to station 10, and the damaged part near the foot of the protection was repaired up to a 15-foot stage.

This work was completed November 23, and the force was then disbanded and the plant towed into winter harbor.

The amount of work done during the season is shown in the following table:

Mattress built and placed, 1,045 linear or 45,000 square feet.

Revetment placed, 1,700 linear or 74,000 square feet.

The old revetment was carried up to heights varying from 15 to 20 feet above low water, and much of the bank above those stages has been eroded by high water and now needs protection. Measurements taken at the close of the season showed that about 28,000 square feet of bank remain to be protected between station 10 and the lower end of the work.

Very respectfully, your obedient servant,

C. D. LAMB,
*Assistant Engineer.*

Maj. CHARLES J. ALLEN,
*Corps of Engineers, U. S. A.*

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## REPORT OF MR. WILLIAM S. MITCHELL, ASSISTANT ENGINEER, ON WORK AT FORT CHARTRES.

ST. LOUIS, MO., *June 30, 1893.*

MAJOR: I have the honor to submit the following report on the progress of the work for improvement of the river in the Fort Chartres Reach during the fiscal year ending June 30, 1893.

The project for these works embraced the revetment of the soft, caving Illinois bank between Sycamore and Fort Chartres landings, and the construction of a series of hurdles to close the chute between the Missouri shore and Fort Chatres or Bruce Island, and thus force this water to pass between the island and the Illinois shore, to the great improvement of the present low-water channel over the persistent and dangerous shoal opposite the lower half of the island.

The general trend of the channel through this reach is from the Missouri shore at Brickey's Mill, crossing above Bruce Island Bar to the Illinois shore at Sycamore Landing; thence following the east bank for about 2 miles it crosses over the shoal to the foot of Bruce Island and back to the Missouri shore above White Sand Depot.

Work was begun on September 6 and continued until the close of the fall season.

The force employed consisted of a mattress and revetment gang for the east side, and six pile-drivers with their crews and a hurdle gang for the west side.

On the east side the low-water mattress, which was of the usual character and width was 5,500 feet in length. It was fabricated and sunk without difficulty in 20 to 35 feet of water, and extends from Sycamore Landing, along the caving bank, to the heavily wooded bank a mile below.

Between the shore edge of the mattress, which was placed at about the level of low water, and the foot of the abrupt bank at about the contour of 10 foot stage, (St. Louis gauge), a stone revetment was laid. This revetment was begun September 13, and followed the mattress as rapidly as it was placed, extending its entire length, and averaging 23.4 feet in width.

Above the 10-foot contour nothing was attempted, it being expected that the bank would be graded approximately to the required slope by the river when at a higher stage, and also that it could be then more economically revetted.

During the season the river fell gradually from 9 to 5 feet (average about 6 feet) on the St. Louis gauge; the current was only strong enough to aid in launching the mattress, and the depths encountered were insufficient to cause any difficulty in sinking it. The rate of progress under these favorable conditions was very good, being 102 linear feet per working day of eight hours, or 85 linear feet daily during the season. The total force employed was about 75 men, and on the completion of this work, November 9, they were transferred to the west side to aid in the construction of the hurdles there.

On the west side, hurdles Nos. 1 and 2 were projected 1,600 feet and 600 feet, respectively, above old stone dam, closing the chute, but when soundings were taken on these lines previous to beginning work the cross sections were found uniformly very deep, 18 to 22 feet at the 9-foot stage (St. Louis gauge) then prevailing. To have driven on these lines would have required excessive lengths of pile timber, and to avoid the expense to be thus incurred the construction of the upper hurdle (No. 1) was abandoned for this season, and the location of No. 2 was changed to the line of the stone dam, the piling being driven through the stone work, the crest of which came about to low-water level. The cost of pile timber was thus reduced and the construction of a foundation mattress was avoided altogether.

Work on the line was begun September 6 at the island, and was continued until October 7, when the piling had been extended across the chute to the rock ledge, within 60 feet of the Missouri shore.

The drift piles were driven 5 feet apart in the upstream slope of the dam and were braced by piles spaced 10 feet apart and driven 7 feet back from them, each brace and its two adjacent piles being drawn together and bolted, forming drift clumps of three piles each, spaced 10 feet apart. In each clump one pile came to the level of a 25-foot stage of river, the other pile and the brace reached the 20-foot stage, at which level all the clumps were connected by a stringer, and a second stringer connected the drift piles at the 10-foot level.

In order that the braces and piles in the hurdle row should not be driven in the back slope of the dam, but in its crest, this line was placed only 12 feet back from the drift clumps. The piles were spaced the usual 6 feet apart and every pile was braced but alternately at the 20 and 10-foot levels, at which levels they were also connected by stringers.

Cross stringers connected the two rows of piling every 12 feet at the 20-foot level and every 20 feet at the 10-foot level.

Near the Missouri shore the dam seemed never to have been completed, and as the shore found here was insufficient to hold the piling, and in some places sand to the depth of 5 to 7 feet was found to overlie the rock ledge from the bluff, a mattress, 268 by 60 feet, was constructed and sunk over this bed of sand to protect it from scour, and after the piles had been driven through it they were further strengthened by stone thrown around them.

From the Missouri shore to the piling a spur dike of stone was built up to the 12-foot level. It was about 125 feet in length, and a part of the stone used in its construction was found on the bank. Another similar but very short spur, about 25 feet in length, connected the east end of the hurdle with the island revetment, and the latter was strengthened and extended upstream 160 feet by a mattress heavily weighted with stone, covering the bank between the low water and 20-foot contours. These spurs and the addition to the island revetment were not undertaken until November 22–26, when the force which had just completed hurdle No. 3 was available for the work.

Before the close of the season small drift had collected along the entire length of the piling in this hurdle from about the 7-foot level to the base of the piles, and it had packed so closely as to create a head of water of about 15 inches above the line, obviating the necessity of wattling in any form.

The total length of hurdle No. 2 is 1,575 feet.

Hurdle No. 3 was begun October 5. It is 1,000 feet below and parallel to hurdle No. 2. The average depth of water found on the line was 6¼ feet and the maximum depth 12 feet, the St. Louis gauge reading 5¼ feet. The construction of this hurdle was similar to that of No. 2, with the following exceptions: that the piles in the drift row were driven 6 feet between centers instead of 5 feet, making the drift clumps 12 feet apart instead of 10 feet; the distance between drift and hurdle rows was widened to 25 feet; no pile rose above the 20-foot stage, and the hurdle was wattled with curtains of brush along its entire length from the foundation mattress to the lower stringer at about the 10-foot level. The river banks at both ends of the hurdle were heavily revetted with stone up to the 20-foot contour, which on the Missouri bank was laid in a mattress. Short stone spurs up to the 12-foot level connected the hurdle ends with these revetments.

The hurdle is 1,950 feet in length and was completed November 22.

On the completion of the stone spurs for the upper hurdle, November 26, the force was discharged and the plant was towed to Bushberg for the winter.

In the spring, March 8, an examination was made of the works to ascertain the damage done by the ice in February, and both hurdles were found to have been broken through.

In hurdle No. 2 there were three gaps, each 100 feet in width, from which the piling had been carried out. That on the west began 200 feet from the Missouri end of the line, and between it and the middle gap the hurdle piles above remained in good condition, all the drift clumps, about 400 linear feet, having been broken down; between the middle and east gaps there remained about 100 feet of the hurdle row only, but badly wrecked and weak.

East of the last gap the drift row was gone for 100 feet further, but the remainder of the hurdle, about 500 feet, was unharmed and in very good condition.

The ice flowing through these gaps in the upper line evidently had united in one stream and had broken the lower hurdle, No. 3, leaving a clear gap 250 feet in length between 600 and 850 feet from the island.

A force was at once organized to repair the hurdles, and March 17, with the necessary plant and materials, was towed to Fort Chartres Island.

Meanwhile the river had risen from a 12-foot stage, at which the works were first examined, to a 20-foot stage, and had brought down large quantities of drift, which had done some additional damage to the upper hurdle and had lodged in enormous masses against the piling.

The small portion of Hurdle No. 2 lying between the middle and east gaps had been carried away, leaving one large gap 300 feet wide, through which the water poured with tremendous current.

In Hurdle No. 3 the gap had increased to 750 feet in width, the drift piles having been scoured out by the flow of water along the piling toward the gap from both sides, and the hurdle piles were broken down by the drift.

In the upper hurdle all the old work was strengthened by additional piles and braces on the lower side, and the west gap was closed twice, but each time the piling was broken down or scoured out, 30 to 35 feet of water being found on the line and the current very swift.

The main gap was narrowed to about 200 feet, working from each side, but beyond that it was found impossible to drive piles, as the water deepened rapidly from 35 to 60 feet in the center of the break, showing that the old stone dam in which the piling had been driven had settled or had been broken by the tremendous pour through this opening, due to the head of water, about 28 inches, created by the sides of the hurdle, the latter having become almost water-tight through the packing in the drift.

The river rose steadily until May 3, when it reached a stage about 5 feet above the average June flood, an almost unprecedented height for a spring rise.

This made the work very difficult and slow, and created a current impossible to withstand in this gap. An attempt was made to close the latter by driving around it in a Λ shape, but even then the depths and current were too great for successful work although a foundation mattress, in sections, was finally placed along the east branch of the Λ and around its head, but the depth of water had become too great, 40 feet, for piling to be driven.

A small section of mattress on the west branch was lost from scouring of anchor piles.

When the river had reached its highest level, Bruce Island and the Illinois shore were overflowed, and all unsunken drift was carried over the hurdles, so that the force was literally drowned out from work.

When the water began to recede a very strong but open curtain or screen, 100 by

250 feet, with its downstream end buoyed up on barrels, was constructed on poles and wire cables to be placed in front of the gap, with the hope that it would check the current sufficiently to induce deposit below it, but it was at once swept from its anchorage, and as the water was still too high for work, and fell very slowly, the force was withdrawn from this line to await a lower stage of river.

While strengthening the old piling in the upper line the enormous mass of drift, 500 feet long by 75 feet wide by 10 feet deep, which had accumulated above the piles between the island and the gap, was sunk by building a mattress over it and weighting it with stone. As more drift accumulated there this process was repeated, and a third mattress was built and sunk over a portion of the line. This sunken mass came nearly to the top of the hurdle and added about 60 feet to the width of its base upstream, making a permeable dam of drift.

The spur dike of stone at the east end of the hurdle was raised to the level of the Island bank, and the revetment of the latter was strengthened and repaired.

The gap in the lower hurdle, No. 3, was narrowed to 250 feet, but as the water then deepened from 40 to 55 feet it was impossible to go farther with the piling.

The mattress was found intact entirely across the break, but it seemed to have settled with the ridge of sand on which it lies, as 75 feet depths were found below it and above as far as the lower side of Hurdle No. 2.

A second small break which developed to the west of the main gap during the high water was quickly closed, and the drift which had collected above the hurdle for 550 and 200 feet at its east and west ends, respectively, was sunk, and the old work was thoroughly strengthened and repaired.

As this completed all work that could be done at this locality the force and plant were removed May 20 to 22, to Pulltight works.

Although there has been great scour in the channel connecting the breaks in the two hurdles, yet their general effect, as well as can be seen from high-water soundings, has been to increase the bars below them, and to give greater channel depths over the bar lying between the Island and the Illinois shore, as was desired.

The excessive and long continued high water, the frequent rains and severe storms throughout the season, interfered with and delayed the work very much and greatly increased its labor and expense.

During September and October a new survey was made by Mr. Freis from Brickeys Mill to the head of Ste. Genevieve Works.

This section of the river is shown on two charts, their junction being at the head of Turkey Island, and during their execution the party was quartered at Fort Chartres Works, but as it was impossible to extend the work farther down stream from that point as a base a small quarter boat was obtained from the Missouri River commission, and Mr. Freis being left in charge at Fort Chartres, the party was moved November 1 to Ste. Genevieve and thence to the Okaw River, and the survey was extended by November 21 to the head of Kaskaskia Cut-off, 17.5 miles from Brickey Mills.

On the following day the party was towed to Quarantine to begin the annual low-water survey through the reaches under improvement. This was completed December 5 and embraced that section of the river lying between Jefferson Barracks and Hurdle No. 6 of the Sulphur Springs series, where it joined the survey completed by Mr. Holman. The outfit was then taken into winter harbor at Bushberg and the party was discharged.

The charts of the survey were completed during the winter and filed.

Very respectfully, your obedient servant,

WM. S. MITCHELL,
*Assistant Engineer.*

Maj. CHAS. J. ALLEN,
*Corps of Engineers, U. S. A.*

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REPORT OF MR. C. D. LAMB, SUPERINTENDENT, ON PROCURING BRUSH.

ST. LOUIS, MO., *June 30, 1893.*

MAJOR: I have the honor to submit the following report on procuring brush during the fiscal year ending June 30, 1893:

Work was begun for the fall season with a small force at Fort Chartres Towhead, on the 12th of August, which was as soon as teams could be handled on the deposit left by the exremely high water of May and June.

About 15 cords of brush per hour were loaded during August, but this rate was increased to suit the demands, 40 cords per hour being handled on many days in October.

The force was disbanded November 11, at Durfees Point, having procured all the brush needed for the season's construction work.

The procuring of brush for the spring season of 1893 was begun with a small force on the 16th of March, at Horsetail Bar, east side.

About 100 cords per working day was loaded at this locality until work was interrupted by high water on the 2d of May. Work was resumed May 16, but again suspended on the 5th of June; resumed on the 8th instant, and continued until the present time.

The time spent and cords procured at each locality are shown as follows:

| Locality. | Time of work. | Cords. |
|---|---|---|
| Fort Chartres Towhead | Aug. 12 to Aug. 15, 1892 | 206.3 |
| Kaskaskia Cut-off | Aug. 16 Aug. 26, 1892 | 643.7 |
| Ste. Genevieve Towhead | Aug. 27 Oct. 11, 1892 | 7,304.8 |
| Missouri shore below Clearyville | Oct. 12 Oct. 14, 1892 | 412.5 |
| Foot of Kaskaskia Island | Oct. 15 Oct. 21, 1892 | 845.5 |
| Durfees Point | Oct. 22 Nov. 11, 1892 | 2,790.4 |
| Horsetail Bar, east side | Mar. 16 Apr. 22, 1893 | 2,583.3 |
| Cliff Cave | Apr. 23 May 2, 1893 | 309.3 |
| Mudds Point | May 15 May 23, 1893 | 402.5 |
| Fosters Island | May 24 May 29, 1893 | 300.0 |
| Sulphur Springs, east side | May 30 June 6, 1893 | 100.0 |
| South bank Missouri River at mouth | June 8 June 15, 1893 | 731.8 |
| Montgomery Towhead | June 16 June 20, 1893 | 400.0 |
| Jim Smith's | June 21 June 30, 1893 | 2,102.3 |
| Total | | 19,132.4 |

The brush procured during the fall season was loaded with the derrick on pile-driver No. 4, having a capacity of 50 cords per hour with 8 laborers. During the winter this was replaced by a derrick set up on pile-driver hull No. 5, which will handle about 60 cords an hour with 6 laborers. This derrick has a mast 42 feet long, supported by sheer and stiff legs, with a boom made of two 7-inch steel channel beams.

The power is furnished by a 20-horse power double-drum double-cylinder hoisting engine, taking steam from the pile-driver boiler.

The average haul during the fall season was longer than for several years past, but improved methods of handling reduced the cost of that part of the work by about 15 per cent, as shown by comparing the fall of 1892 with that of 1891, when the amount procured was about the same.

| | 1892. | 1891. |
|---|---|---|
| Cost of— | | |
| Cutting and loading, per cord | $0.43 | $0.51 |
| Hauling, per cord | .35 | .20 |
| Material, per cord | .03 | .03 |
| Subsistence, per cord | .16 | .16 |
| Royalty, per cord | .05 | .08 |
| Total | 1.02 | .98 |

With a medium haul this cost can be probably further reduced.

Very respectfully, your obedient servant,

C. D. LAMB,
*Superintendent.*

Maj. CHAS. J. ALLEN,
*Corps of Engineers, U. S. A.*

## REPORT OF MR. WILLIAM S. MITCHELL, ASSISTANT ENGINEER, ON PROCURING STONE.

ST. LOUIS, MO., *June 30, 1893.*

MAJOR: I have the honor to submit the following report of operations at the quarry for procuring riprap, at Little Rock, Mo., for the fiscal year ending June 30, 1893:

As the quarries near St. Louis could not be relied upon to furnish stone cheaply enough to admit of the long tow to the works as they progressed each year further downstream, it was decided to open a quarry in the vicinity of the prospective works for the next four years, and in September a lease or quarry right was obtained to procure riprap from the land of Andrew F. Wilder and Herman Weber, extending about two-thirds of a mile along the bluff above Little Rock landing and for 600 feet back from the river. For this privilege there was charged a royalty of 2 cents per cubic yard of riprap removed and a small rental, $25 per year, for ground occupied by the buildings erected for office quarters, tool houses, etc.

The site is admirably adapted for the purpose, and two quarries had already been opened on the property, but neither had been worked for some years, and then they were evidently worked very badly and cheaply for small quantities of stone without stripping or clearing away refuse spalls.

Work was begun September 11 to clear up the lower quarry on Mr. Wilder's land, and at first only about 100 cubic yards were procured daily. The quantity was gradually increased until, in November, 350 cubic yards per day were had, which was the maximum that could be handled with barrows on the available river front of this quarry.

In October the second quarry was opened about one-half mile further upstream on the Weber land, but only about 50 cubic yards were procured daily.

Work was suspended November 22, but during the winter a small force was employed in stripping the lower quarry and building a loading terrace and tramway to be used when loading with derricks.

In the spring work was resumed, but not upon a large scale as only one construction work to be supplied with stone was carried on in the vicinity. The loading track was laid, but during the very high water in May it was flooded.

During the latter part of May the force was much reduced, only being retained to prepare for active work in the fall by completing the terrace, preparing stations for the loading derrick, and raising the track about 4 feet, so as to be above the level of any probable high water, and increasing its grade that the cars may be delivered more quickly to the derricks.

During the fall season almost all of the drilling was done by hand, but a steam drill belonging to the department was also set up and used. In the spring the drill, having been put up in thorough good order, was used continually and much hand drilling avoided.

A derrick was erected on a pile-driver, and during June was used very successfully to load the few barges required, although it was only a temporary expedient. With this exception all loading has been done with barrows. This will be changed when stationary derricks are erected.

Blasting has been done with dynamite, 40 per cent pure nitroglycerine.

In the fall the force was subsisted and lodged in the department's quarters, but as laborers could be had who lived in the vicinity the quarters were not used in the spring and no one was subsisted.

Nearly 19,000 cubic yards of stone were procured during the year, at a cost of about 65 cents per cubic yard loaded on barges ready for removal. The total expense of the quarry has been greater then this, but the excess has gone toward fitting it for future work. With a demand for large quantities of stone, and with the loading tracks and derricks in operation, it is thought that the rate will not exceed 50 cents per cubic yard, but only with eight hours per day it will hardly be possible to quarry directly for riprap as cheaply as it can be bought from quarries which sell it as refuse, but the added expense of a long tow in the latter case will more than overbalance the difference in first cost.

The quarries were opened and operated until March 1, by Mr. Lamb, from whose reports the facts given relative to that time have been taken.

Very respectfully, your obedient servant,

Wm. S. Mitchell,
*Assistant Engineer.*

Maj. Chas. J. Allen,
*Corps of Engineers, U. S. A.*

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## REPORT OF MR. C. D. LAMB, SUPERINTENDENT, ON ENGINEER DEPOT.

United States Engineer Depot,
*St. Louis, Mo., June 30, 1893.*

Major: I have the honor to submit the following report of operations at the engineer depot during the fiscal year ending June 30, 1893:

The work done at this place comes under two general heads—the extraordinary, which includes the work of construction and such repairs as increase the value of the plant, and the ordinary, which includes miscellaneous work and repairs to plant required to maintain it in a condition suitable for use.

*Extraordinary.*—The wooden leads, sills, and braces on pile-driver No. 17 were taken down and replaced by steel bars of the shape and length required. Five sets of steel leads, complete with all necessary chocks and kevels, were prepared for setting upon the new hulls being built by contract at Cincinnati. The leads on pile-driver No. 5 were taken down and a derrick set up in their place 42 feet high, with sheer and stiff legs, and a 20-horse-power hoisting engine was placed in the cabin for use in loading brush.

Two new barges, Nos. 114 and 115, received from the contractor at Paducah, were supplied with iron pumps and made ready for service.

A set of temporary quarters for 60 men was built on each of barges Nos. 1, 3, and 5.

Four caulking flats, each 8 inches by 7½ by 27½ feet, were built for use in repairing barges.

Sixty new skiffs received from Truscott & Sons, of Michigan, were painted two coats and made ready for service.

Twelve trucks and boxes were constructed for use at the quarry, 200 stage planks were made from Oregon fir, and other tools made as required.

Eighteen new ice chests were constructed, 2 each for the 3 sets of temporary quarters, 1 each for the 6 sets of portable buildings on barges, and 2 each for 3 new office and quarter boats.

A set of models was made of papiermaché for the World's Fair at Chicago, one on a scale of $\frac{1}{1200}$, showing a portion of the river at Horsetail Bar with the construction work built there and its effect; one on a scale of $\frac{1}{80}$, showing part of a contraction work in process of construction with the necessary plant; another on the same scale of a protection work and the equipment used. A model of a barge was also made of wood to a scale of $\frac{1}{24}$, showing all the details of construction.

*Ordinary.*—The following statement shows the repairs made upon the plant during the year, including the work done at the winter harbor during the late summer and early spring.

The wheel of the steamer General Gillmore was repaired, and the knee and swinging fenders and both strainer plates renewed.

Launches Nos. 1 and 2 were both painted two coats and their nosing and wheels renewed.

The leads of pile-drivers Nos. 8, 9, 10, 11, 13, 15, 17, and 18 were entirely renewed and one new lead set up on Nos. 1, 3, and 20. Two new sills were put in on Nos. 7, 8, 11, 15, 16 and 18, and one each on Nos. 9, 10 and 19. The roofs on Nos. 5, 7, 8, 9, 10, 16 and 20 were renewed and repairs made upon the crab frames, braces, chocks, hulls, and cabins of all the drivers as required. Small repairs were also made at the depot upon the machinery of Nos. 1, 3, 7, 8, 10, 11, 12, 13, 15, 16, 17, and 18 by the engineer and machinist.

The stems of barges Nos. 2, 4, 6, 8, 9, and 29 were renewed, and one each put in Nos. 3, 11, and 30. A new capstan was placed on No. 6, and one on No. 9, and the top sides of all the barges were calked and repaired in the fall and spring.

The flats, skiffs, and yawls on hand at the depot during the summer were calked in the fall, and at the close of the season 65 flats, 42 skiffs, and 9 yawls were pulled out upon the bank and repaired in the spring when required for work.

Various repairs were made upon tools and appliances and boarding outfit.

A shipping shed 14 by 30 feet was built at the depot near the upper end of the gangway. The road was covered with cinders and a new bridge built across the causeway near the middle of the yard.

Subsistence stores and supplies of all kinds were ordered and shipped to the works below when required.

Very respectfully, your obedient servant,

C. D. LAMB,
*Superintendent.*

Maj. CHAS. J. ALLEN,
*Corps of Engineers, U. S. A.*

*Detail construction account, showing cost of works during fiscal year ending June 30, 1893.*

| Labor, plant, and material. | Twin Hollows hurdles. | Pulltight hurdles. | Chesley Island protection. | Rush tower hurdles. |
|---|---|---|---|---|
| Labor, superintendence, etc | $5,706.29 | $16,190.78 | $1,927.73 | $11,343.03 |
| U. S. Engineer office | 593.92 | 1,580.80 | 267.04 | 1,226.11 |
| General expense | 745.04 | 1,967.20 | 225.91 | 1,362.19 |
| Telephone | | | 6.36 | 10.37 |
| Gauge-readers | | | 34.31 | 56.00 |
| Care of plant | 486.43 | 1,297.28 | 84.47 | 902.05 |
| Care of material | 108.05 | 288.00 | 6.50 | 301.72 |
| Steamer Gen. Gillmore | 3,042.00 | 4,602.00 | 597.25 | 2,458.56 |
| Launches | 96.72 | 256.68 | | 214.58 |
| Barges | 1,413.20 | 3,431.12 | 556.85 | 2,448.56 |
| Quarter barges | 360.00 | 604.60 | | 546.86 |
| Pile-drivers | 479.02 | 2.037.74 | | 1,784.94 |
| Machine shop | | 48.00 | 19.25 | 40.63 |
| Small boats | 688.37 | 1,680.24 | 114.71 | 1,362.64 |
| Portable quarters | 100.80 | 275.10 | | 133.39 |
| Supply depot | 106.16 | 281.60 | 2.46 | 200.43 |
| Tools and appliances | 189.53 | 455.94 | 99.30 | 507.69 |
| Boarding outfit | 235.48 | 522.68 | | 502.16 |
| Office furniture | 5.85 | 15.00 | 2.44 | 11.78 |
| Subsistence | 1,509.26 | 3,349.88 | | 3,008.75 |
| Brush | 1,427.05 | 4,434.40 | 314.10 | 2,119.55 |
| Piles | 647.05 | 5,136.88 | | 2,145.50 |
| Stone | 1,868.88 | 2,791.53 | 1,580.79 | 3,149.24 |
| Rope | 25.80 | 202.40 | 55.93 | 363.07 |
| Wire | 135.55 | 446.60 | 14.10 | 153.96 |
| Iron | | | | |
| Nails | 17.16 | 52.31 | 9.76 | 24.70 |
| Spikes | 75.98 | 166.37 | 5.26 | 62.96 |
| Bolts | 25.30 | 165.74 | | 76.30 |
| Lumber | 2.99 | 48.30 | 9.66 | 6.80 |
| Oakum | | 3.90 | | |
| Coal | 51.81 | 665.61 | | 231.78 |
| Coal, blacksmiths | | 88 | | |
| Ice | 69.57 | 154.42 | | 231.24 |
| Miscellaneous material | 44.56 | 276.20 | 4.00 | 95.72 |
| Total | 20,257.82 | 53,500.78 | 5,938.18 | 37,082.76 |

| Labor, plant, and material. | Rush tower protection. | Fort Chartres. | | Total. |
|---|---|---|---|---|
| | | Hurdles. | Protection. | |
| Labor, superintendence, etc | $10,664.82 | $18,457.47 | $5,358.52 | $69,648.64 |
| U. S. Engineer office | 1,503.88 | 2,224.79 | 758.97 | 8,155.51 |
| General expense | 1,271.93 | 2,288.70 | 642.06 | 8,523.03 |
| Telephone | 35.79 | 29.42 | 18.06 | 100.00 |
| Gauge readers | 193.24 | 158.93 | 97.52 | 540.00 |
| Care of plant | 1,098.14 | 1,655.50 | 675.76 | 6,199.63 |
| Care of material | 590.24 | 641.01 | 365.85 | 2.301.37 |
| Steamer Gen. Gillmore | 5,442.62 | 5,280.64 | 2,080.73 | 23,503.80 |
| Launches | 272.38 | 397.73 | 81.17 | 1,319.28 |
| Barges | 3,677.85 | 4,922.45 | 2,666.19 | 19,166.22 |
| Quarter barges | 591.55 | 1,026.75 | 981.16 | 4,110.92 |
| Pile-drivers | 2,328.72 | 5,782.80 | 385.62 | 12,798.84 |
| Machine shop | 162.08 | 150.87 | 33.33 | 454.16 |
| Small boats | 1,929.81 | 3,311.76 | 1,539.09 | 10,626.62 |
| Portable quarters | 619.78 | 553.40 | 359.77 | 2,042.24 |
| Supply depot | 206.70 | 365.70 | 138.10 | 1,301.15 |
| Tools and appliances | 835.34 | 392.84 | 171.97 | 2,652.61 |
| Boarding outfit | 575.69 | 799.02 | 295.87 | 2,930.90 |
| Office furniture | 13.90 | 21.05 | 6.94 | 77.56 |
| Subsistence | 2,790.71 | 4,451.10 | 1,437.68 | 16,547.38 |
| Brush | 6,289.43 | 2,843.50 | 4,547.85 | 21,975.88 |
| Piles | | 8,283.26 | | 16,212.69 |
| Stone | 7,860.44 | 4,907.69 | 4,530.59 | 26,689.16 |
| Rope | 801.67 | 1,154.65 | 691.66 | 3,295.18 |
| Wire | 311.97 | 297.77 | 215.39 | 1,575.34 |
| Iron | | 3.67 | | 3.67 |
| Nails | 52.52 | 32.74 | 78.08 | 267.27 |
| Spikes | 117.03 | 104.90 | 97.84 | 630.34 |
| Bolts | | 762.69 | | 1,030.03 |
| Lumber | 25.29 | | 21.00 | 113.45 |
| Oakum | 1.26 | 6.89 | | 12.05 |
| Coal | 88.16 | 706.63 | 39.18 | 1,783.17 |
| Coal, blacksmiths | | | | .88 |
| Ice | 181.55 | 381.99 | 101.56 | 1,120.33 |
| Miscellaneous material | 86.14 | 456.38 | 57.61 | 1,020.61 |
| Total | 50,620.54 | 72,854.69 | 28,475.12 | 268,729.89 |

*Construction account, showing cost of works to June 30, 1893.*

| Name of work. | Expended— |  | Total cost to June 30, 1893. |
|---|---|---|---|
|  | Prior to July 1, 1892. | During fiscal year ending June 30, 1893. |  |
| Piasa Island Dam | $37,910.41 | ............ | $37,910.41 |
| Piasa Island Dam, cutting channel | 3,116.86 | ............ | 3,116.86 |
| Alton Dam | 33,740.05 | ............ | 33,740.05 |
| Alton Dike | 126,652.74 | ............ | 126,652.74 |
| Sawyer Bend, protection | 96,803.63 | ............ | 96,803.63 |
| Venice Dikes | 36,341.85 | ............ | 36,341.85 |
| St. Louis Harbor | 144,048.94 | ............ | 144,048.94 |
| Arsenal Island, protection | 42,599.06 | ............ | 42,599.06 |
| Closing Cahokia Chute | 119,958.21 | ............ | 119,958.21 |
| Channel opposite St. Louis | 58,455.54 | ............ | 58,455.54 |
| Horsetail Bar, dikes 1 to 5, inclusive | 225,066.31 | ............ | 225,066.31 |
| Horsetail Bar, training wall | 81,253.28 | ............ | 81,253.28 |
| Horsetail Bar, hurdles | 548,834.08 | ............ | 548,834.08 |
| Horsetail Bar, bank protection | 40,993.55 | ............ | 40,993.55 |
| Carrolls Island, hurdle | 4,093.58 | ............ | 4,093.58 |
| Twin Hollows, west side, hurdles | 248,837.82 | $20,257.82 | 269,095.64 |
| Twin Hollows, west side, bank protection | 31,370.55 | ............ | 31,370.55 |
| Twin Hollows, east side, bank protection | 128,920.30 | ............ | 128,920.30 |
| Pulltight, hurdles | 340,778.57 | 53,500.78 | 394,279.35 |
| Beards Island, primary hurdle | 7,166.24 | ............ | 7,166.24 |
| Beards Island, bank protection | 84,258.76 | ............ | 84,258.76 |
| Jim Smiths, hurdles | 365,803.33 | ............ | 365,803.33 |
| Jim Smiths, bank protection | 7,569.58 | ............ | 7,569.58 |
| Chesley Island, bank protection | 64,416.04 | 5,938.18 | 70,354.22 |
| Chesley Island, hurdles | 27,808.61 | ............ | 27,808.61 |
| Sulphur Springs, hurdles | 177,964.24 | ............ | 177,964.24 |
| Lucas, hurdles | 128,056.65 | ............ | 128,056.65 |
| Foster Island | 44,296.02 | ............ | 44,296.02 |
| Rush Tower, hurdles | 174,769.14 | 37,082.76 | 211,851.90 |
| Rush Tower, protection | 15,630.18 | 50,620.54 | 66,250.72 |
| Fort Chartres Dam | 36,812.86 | ............ | 36,812.86 |
| Fort Chartres, west side, hurdles | ............ | 72,854.69 | 72,854.69 |
| Fort Chartres, east side, bank protection | ............ | 28,475.12 | 28,475.12 |
| Turkey Island | 24,463.85 | ............ | 24,463.85 |
| St. Genevieve, hurdles | 47,171.06 | ............ | 47,171.06 |
| Kaskaskia, protection | 66,465.62 | ............ | 66,465.62 |
| Liberty Island Dam | 5,053.91 | ............ | 5,053.91 |
| Liberty Island, protection | 45,129.40 | ............ | 45,129.40 |
| Devils Island, Dike 1 | 65,871.17 | ............ | 65,871.17 |
| Devils Island, Dams 1 and 2 | 66,526.88 | ............ | 66,526.88 |
| Minton Point, hurdles | 33,436.37 | ............ | 33,436.37 |
| Cape Girardeau, primary hurdles | 31,930.18 | ............ | 31,930.18 |
| Cairo, protection | 160,439.82 | ............ | 160,439.82 |
| Total | 4,030,815.24 | 268,729.89 | 4,299,545.13 |

*Property account.*

| Class of property. | Value July 1, 1892. | Purchases, additions, and repairs. | Expenses and deterioration charged to works of improvement. | Value June 30, 1893. |
|---|---|---|---|---|
| Steamer General Gillmore | $12,727.94 | $21,647.84 | $23,508.80 | $10,871.98 |
| Steam launches | 5,466.62 | 688.65 | 1,572.90 | 4,582.37 |
| Steam tenders | ............ | 10,060.38 | ............ | 10,060.38 |
| Barges, model | 78,299.35 | 25,051.38 | 26,666.22 | 76,684.51 |
| Barges, with quarters | 13,716.81 | 8,105.75 | 4,655.75 | 17,166.81 |
| Quarter boats | ............ | 1,733.33 | ............ | 1,733.33 |
| Pile-drivers | 32,893.68 | 13,606.73 | 14,966.86 | 31,533.55 |
| Machine shop | 2,399.51 | 34.25 | 490.16 | 1,943.60 |
| Derrick boat | ............ | 1,500.00 | ............ | 1,500.00 |
| Small boats | 9,663.97 | 13,593.44 | 10,987.42 | 12,269.99 |
| Portable quarters | 6,154.65 | 3,224.24 | 2,327.71 | 7,051.18 |
| Tents | 190.75 | ............ | ............ | 190.75 |
| Supply depot | 3,441.00 | 965.65 | 1,301.15 | 3,105.50 |
| Tools and appliances | 3,032.56 | 6,756.99 | 3,054.76 | 6,734.79 |
| Boarding outfit | 9,314.31 | 5,513.55 | 2,930.90 | 11,896.96 |
| Office furniture | 385.63 | 143.20 | 77.56 | 451.27 |
| Survey instruments | 613.70 | 81.75 | 61.37 | 634.08 |
| Photographic apparatus | 230.16 | 50.00 | 23.02 | 257.14 |
| Total | 178,530.64 | 112,757.18 | 92,619.58 | 198,668.19 |

*Material account.*

| Class of material. | Value— |  | Expended and charged to works of improvement. | Value on hand June 30, 1893. |
|---|---|---|---|---|
|  | July 1, 1892. | Purchased. |  |  |
| Subsistence | $452.43 | $21,823.65 | $21,776.08 | ............ |
| Brush | 765.65 | 21,210.23 | 21,975.88 | ............ |
| Piles | 2,123.35 | 14,398.09 | 16,250.67 | $270.77 |
| Stone | 813.34 | 26,417.48 | 26,689.16 | 541.66 |
| Rope | 7,416.44 | 7,360.06 | 3,525.57 | 11,250.93 |
| Wire | 156.71 | 1,466.22 | 1,575.34 | 47.59 |
| Iron | 248.30 | 3,796.70 | 683.54 | 3,361.46 |
| Nails | 258.08 | 665.72 | 381.42 | 542.38 |
| Spikes | 338.49 | 814.99 | 710.61 | 442.87 |
| Bolts, screw | 1,684.63 | 836.49 | 1,223.21 | 1,297.91 |
| Bolts, assorted | 37.76 | 40.41 | 40.75 | 37.42 |
| Lumber | 391.51 | 5,503.24 | 4,778.31 | 1,116.44 |
| Oakum | 36.24 | 769.50 | 563.30 | 242.44 |
| Coal | 7.00 | 7,273.19 | 7,280.19 | ............ |
| Coal, blacksmiths | 15.91 | 41.93 | 52.77 | 5.07 |
| Ice | ............ | 1,720.52 | 1,720.52 | ............ |
| Miscellaneous material | 376.56 | 18,921.81 | 8,716.55 | 10,581.82 |
| Total | 15,122.40 | 132,560.23 | 117,943.87 | 29,738.76 |

*Depth of water in feet upon the*

| Number of trips. | Date. | Stage above standard low water by St. Louis gauge. | Name of steamer furnishing report. | Direction. | Arsenal Island. | Quarantine. | Pulltight. | Twin Hollow. | Fines Bluff. | Maramec River. | Sulphur Springs. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1892. | *Feet.* | | | | | | | | | |
| 1 | July 2 | 24.50 | City of New Orleans | Down | | | | | | | |
| 2 | 12 | 26.40 | City of Providence | do | | | | | | | |
| 3 | 16 | 25.60 | City of St. Louis | do | | | | | | | |
| 4 | 17 | 25.20 | H. M. Hoxie | do | | | | 18 | | | |
| 5 | 21 | 23.20 | City of New Orleans | do | | | | | | | |
| 6 | 27 | 18.90 | City of Hickman | do | | | | 15 | | | |
| 7 | 27 | 18.90 | City of Providence | do | | | | | | | |
| 8 | 29 | 16.50 | City of Monroe | do | | | | 15 | | | |
| 9 | 31 | 15.20 | Sidney Dillon | do | | | | 13½ | | 21 | 18 |
| 10 | Aug. 1 | 14.80 | H. M. Hoxie | Up | | | | 9½ | | 16½ | |
| 11 | 3 | 13.50 | City of Cairo | Down | | | | 10½ | | | |
| 12 | 5 | 12.50 | Arkansas City | do | | | 12 | | | 18 | |
| 13 | 9 | 10.80 | Gen. Gillmore | do | 16½ | | 12 | | | 21 | |
| 14 | 10 | 10.40 | City of New Orleans | do | | | | | | | |
| 15 | 12 | 60.00 | City of Monroe | do | | | | | | | |
| 16 | 12 | 60.00 | do | do | | | | 12 | | 18 | |
| 17 | 14 | 60.10 | S. H. H. Clark | do | | | | 9 | | 15 | |
| 18 | 15 | 9.40 | Gen. Gillmore | do | 15 | | 9 | | | 12 | |
| 19 | 16 | 9.10 | City of Cairo | do | 13½ | | | 9½ | | 12 | 15 |
| 20 | 17 | 8.90 | City of Hickman | do | 12 | | | 8 | | | |
| 21 | 18 | 8.50 | City of Providence | do | | | | 9½ | | | |
| 22 | 22 | 7.40 | Gen. Gillmore | do | 13½ | | 9 | | | 12 | |
| 23 | 22 | 7.40 | Arkansas City | do | | | | 7½ | | | |
| 24 | 30 | 5.50 | City of Cairo | do | | | | | | | |
| 25 | 30 | 5.50 | Jay Gould | do | 10½ | | | 8 | | 7 | 12 |
| 26 | Sept. 1 | 5.60 | Gen. Gillmore | do | 10½ | | 7½ | | | | |
| 27 | 3 | 5.40 | My Choice | do | 9 | | | 6 | | | 9 |
| 28 | 4 | 5.30 | Jack Frost | Up | 13½ | 12 | | | 9 | | 10½ |
| 29 | 5 | 5.20 | Gen. Gillmore | Down | 12 | | 6½ | | | | |
| 30 | 6 | 4.80 | Arkansas City | do | | | | | | | |
| 31 | 8 | 4.60 | City of Providence | do | | | 5½ | 5½ | | | |
| 32 | 9 | 4.30 | City of Hickman | do | 9 | | | | | 9 | |
| 33 | 12 | 4.40 | Gen. Gillmore | do | 9 | | 6 | | | 9 | 16½ |
| 34 | 14 | 5.00 | My Choice | do | | | | 6½ | | | |
| 35 | 15 | 4.70 | City of Cairo | do | | | | | | | |
| 36 | 15 | 4.70 | City of St. Louis | do | 10½ | | 7½ | | | | 10½ |
| 37 | 19 | 4.00 | Gen. Gillmore | do | 9 | | 5 | | | | 13½ |
| 38 | 20 | 3.90 | State of Kansas | do | | | | | | | |
| 39 | 20 | 3.90 | Arkansas City | do | | | | 6 | | 8 | |
| 40 | 22 | 3.70 | Gen. Gillmore | do | | | | | | 8 | |
| 41 | 27 | 3.16 | City of Providence | do | | | | 5 | | | |
| 42 | 28 | 3.00 | A. L. Mason | do | | | | | | | |
| 43 | 29 | Gauge covered with mud. | Gen. Gillmore | do | 9 | | 7 | | | 8½ | 15 |
| 44 | 30 | | do | do | | | | | | | |
| 45 | 30 | | City of Hickman | do | 9 | | | | | 7½ | |
| 46 | Oct. 3 | 2.70 | Gen. Gillmore | do | 8 | | 5 | 7½ | | | |
| 47 | 7 | 2.00 | do | do | | | | | | | |
| 48 | 7 | 2.00 | Paul Tulane | do | | | | | | | |
| 49 | 8 | 1.80 | State of Kansas | do | 7 | | | 8 | | | 9 |
| 50 | 10 | 1.60 | Gen. Gillmore | do | 8 | | 4½ | 7½ | | | |
| 51 | 11 | 1.50 | do | do | | | | | | | |
| 52 | 13 | 1.20 | War Eagle | do | | | | 4½ | | | 8 |
| 53 | 17 | 1.30 | Gen. Gillmore | do | 7 | | 4 | 6 | | 7 | |
| 54 | 18 | 1.00 | do | do | | | | | | | |
| 55 | 25 | 1.00 | Grey Eagle | do | | | | 5 | | | |
| 56 | 27 | 1.10 | Gen. Gillmore | do | 7 | | 4½ | 7 | | | |
| 57 | 31 | 2.10 | do | do | 8½ | | 5 | 7½ | | | |
| 58 | Nov. 7 | 1.30 | do | do | 7 | | 5 | 6 | | 8 | |
| 59 | 10 | 1.00 | do | do | | | | | | | |
| 60 | 14 | 1.00 | do | do | 7½ | | 4 | 7 | | 6½ | |
| 61 | 21 | 1.10 | do | do | 7½ | | 4½ | | | 6½ | |
| 62 | Dec. 14 | 1.40 | Grey Eagle | do | | | | | | | |
| | 1893. | | | | | | | | | | |
| 63 | Feb. 16 | 4.00 | My Choice | do | | | | 9 | | 8½ | |
| 64 | 22 | 5.40 | City of New Orleans | do | | | | 9½ | | | |
| 65 | Mch. 1 | 8.00 | City of Hickman | do | | | | 10½ | | | |
| 66 | 29 | 14.00 | City of St. Louis | do | | | | | | | |
| 67 | Apr. 1 | 13.00 | Arkansas City | do | | | | | | | |
| 68 | 2 | 12.70 | Hy. Lowry | Up | | | | | | | |
| 69 | 7 | 12.40 | City of New Orleans | Down | | | | 15 | | | |
| 70 | 8 | 12.50 | H. M. Hoxie | Up | | | | 15 | | | 18 |
| 71 | 10 | 12.80 | Hy. Lowry | Down | | | | 13½ | | | 15 |
| 72 | 10 | 12.80 | City of Vicksburg | do | | | | 15 | | | |
| 73 | May 20 | | H. M. Hoxie | do | | | | | | | 16½ |
| 74 | June 7 | 22.00 | do | do | | | | | | | 16½ |
| 75 | 18 | 16.90 | do | do | | | | 22½ | | 12 | 16½ |
| 76 | 21 | 14.60 | City of St. Louis | do | | | | | | | |
| 77 | 21 | 14.60 | City of Hickman | do | | | | | | | |

*bars between St. Louis and Cairo.*

| Harrisonville. | Lucas. | Herculaneum. | Swashin. | Calico Island. | Cornice Island. | Forest Home Landing. | Perry Tow Head. | Rush Tow Head. | Salt Lake Landing. | Brickey Mill. | Fort Chartres Landing. | Crookes Landing. | Stantons Landing. | St. Genevieve. | Moro Island. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | |
| | 21 | | | | | | 18 | | 16½ | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | 16½ | | | | | 12 | |
| | | | | | | | | | | | | | | 18 | |
| 18 | | | | | | 16½ | 16 | | | | 13¾ | | | | |
| | 18 | | | | | | | | | | 16½ | | 12 | | |
| | 21 | | | | | 19½ | | | 8½ | | | | | | |
| 16½ | | | | | | 29 | 10½ | | | | 9½ | | | | |
| | | | | | 18 | 12 | 9½ | | | | 9½ | | | | |
| | | | | | | 12 | 10½ | | | | 10½ | | | 12 | |
| 15 | | | | | | 13½ | | | | | 8½ | | | | |
| | | | | | | | 9 | | | | 7 | | | 7 | |
| 18 | | | | | 13½ | 10½ | | 12 | | 7 | | | 18 | | |
| | | | | | | | | | | | | | | | |
| | | | | | 15 | 16½ | 9 | | | | 8 | | | | |
| 12 | | | | | 12 | 12 | 8 | | | | 7½ | | | 13½ | |
| | | | | | | | | | | | 8 | | | | |
| | | | | | 12 | 12 | 8 | 12 | | | 7 | | | 7½ | |
| 9 | | | | | 12 | 10½ | 8 | | | | 7 | | | | |
| 15 | | | | | 13 | 12 | 9½ | | | | 8 | | | | |
| | | | | | | 9½ | 10½ | | | | 7½ | | | 8 | |
| | | | 10½ | | 12 | | 8½ | 12 | | | 7 | | 8 | | |
| | | | | | | | | | | | | | | | |
| | | | 8 | | 8½ | 9 | 8½ | 8½ | | | 6½ | | | 10½ | |
| | | | 8 | | 8 | 9 | 8½ | 8½ | | | 6 | | | 10 | |
| | | | | | | | 10½ | | | | 8 | | | | |
| | | | | | 13½ | | | | | 7 | | 16½ | | 7 | 8 |
| | | | | | | | 12 | | | | 7 | | | 6 | |
| | | | 7½ | | | | 8 | | | | 6½ | | | 8½ | 10½ |
| 10½ | | | 7 | | 6 | 12 | | 9 | | | | | | | |
| 5 | | | | | | 8 | | | | | 5 | | | | |
| | | | | | 10½ | | 10½ | 8 | | | 7 | | | 7½ | |
| | | | | | 10½ | 9 | | | | | 6½ | | | | |
| | | | | | 9 | | | | | | 8 | | | | |
| | | 7½ | | | | | 7 | | | | 6½ | | | 7 | |
| 9½ | | | | | 8½ | | 9½ | | | | | | | 6 | |
| 8 | | | | | 9 | 9 | 8 | | | | 5½ | | 6 | | |
| 10½ | | | | | | | 9 | | | | 5½ | | | | 7 |
| | | | | | | | | | | | 6 | | | | |
| | | | | | | 8 | | | | | 5½ | | | | |
| | | | | | | | | | | | 6 | | 5½ | | 7 |
| 9 | | | | | 10½ | | | 8 | | | 5½ | | | 7 | |
| | | | | | | | | | | | | | | | |
| | | | 6 | | | 10½ | 8½ | | | | 5 | | 9 | | |
| 9 | | | | | 9 | | 9½ | | | | 6 | | | 6 | |
| | | | | | | | | | | | | | | | |
| | | | 5½ | | | | | | | | | | | 5½ | |
| 6½ | | | 6 | | 9 | | | | | | 5 | | | 5 | |
| 8 | | | | | | | 10½ | | | | 5 | | | 6 | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | 4½ | | | | |
| 6½ | | | | | | | 8 | | | | 4 | | | | |
| | | | | | | | | | | | | | | 6 | |
| | | | | | | | | | | | 4½ | | 5 | | |
| | | | | | | | | | | | 5½ | | | 5½ | |
| | | | | | | | 12 | | | | 5 | | | | |
| 8 | | | | | | | | | | | | | | | |
| | | | | | | | 9 | | | | 4½ | | | | |
| 7 | | | | | | | 10½ | | | | 4 | | | | |
| 8 | | | | | | | 9 | | | | 4 | | | | |
| | | | | | | | | | | | | | | | |
| | | | 7 | | | | | | | | 5½ | | | | |
| | | | | | | | | | | 9 | | | | 7 | |
| | | | | | | | | | | | 9 | | 12 | | |
| | | | | | | | | | | | | | | 16½ | |
| | | | | | | | | | | | 10½ | | | | |
| | | | | | 18 | | 16½ | | | | 16½ | | | | |
| | | | | | | | | | | | 10½ | | | | |
| | | | 16½ | | 16½ | 16½ | 15 | | | | 13½ | | | | |
| | | | 13½ | | | 15 | | | | | 9½ | | | 13½ | |
| | | | | | | | | | | 12 | | | 13 | | |
| | 16½ | | | | | 18 | | | | | 18 | | | 10½ | |
| | | | | | | 21 | | | | | 16½ | | | 16½ | |
| | 15 | | | | | 16½ | 18 | | | | 15 | | | | |
| | | | 13½ | | | | | | | | 10½ | | | 16½ | |
| | | | | | | 15 | | | | | 13½ | | | | |

*Depth of water in feet upon the*

| Number of trips. | Date. | Stage above standard low water by St. Louis gauge. | Name of steamer furnishing report. | Direction. | Arsenal Island. | Quarantine. | Pulltight. | Twin Hollow. | Fines Bluff. | Maramec River. | Sulphur Springs. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1892. | *Feet.* | | | | | | | | | |
| 1 | July 2 | 24.50 | City of New Orleans | Down | | | | | | | |
| 2 | 12 | 26.40 | City of Providence | do | | | | | | | |
| 3 | 16 | 25.60 | City of St. Louis | do | | | | | | | |
| 4 | 17 | 25.20 | H. M. Hoxie | do | | | | 18 | | | |
| 5 | 21 | 23.20 | City of New Orleans | do | | | | | | | |
| 6 | 27 | 18.90 | City of Hickman | do | | | | 15 | | | |
| 7 | 27 | 18.90 | City of Providence | do | | | | | | | |
| 8 | 29 | 16.50 | City of Monroe | do | | | | 15 | | | |
| 9 | 31 | 15.20 | Sidney Dillon | do | | | | 13½ | | 21 | 18 |
| 10 | Aug. 1 | 14.80 | H. M. Hoxie | Up | | | | 9½ | | 16½ | |
| 11 | 3 | 13.50 | City of Cairo | Down | | | | 10½ | | | |
| 12 | 5 | 12.50 | Arkansas City | do | | | 12 | | | 18 | |
| 13 | 9 | 10.80 | Gen. Gillmore | do | 16½ | | 12 | | | 21 | |
| 14 | 10 | 10.40 | City of New Orleans | do | | | | | | | |
| 15 | 12 | 60.00 | City of Monroe | do | | | | | | | |
| 16 | 12 | 60.00 | do | do | | | | 12 | | 18 | |
| 17 | 14 | 60.10 | S. H. H. Clark | do | | | | 9 | | 15 | |
| 18 | 15 | 9.40 | Gen. Gillmore | do | 15 | | 9 | | | 12 | |
| 19 | 16 | 9.10 | City of Cairo | do | 13½ | | | 9½ | | 12 | 15 |
| 20 | 17 | 8.90 | City of Hickman | do | 12 | | | 8 | | | |
| 21 | 18 | 8.50 | City of Providence | do | | | | 9½ | | | |
| 22 | 22 | 7.40 | Gen. Gillmore | do | 13½ | | 9 | | | 12 | |
| 23 | 22 | 7.40 | Arkansas City | do | | | | 7½ | | | |
| 24 | 30 | 5.50 | City of Cairo | do | | | | | | | |
| 25 | 30 | 5.50 | Jay Gould | do | 10½ | | | 8 | | 7 | 12 |
| 26 | Sept. 1 | 5.60 | Gen. Gillmore | do | 10½ | | 7½ | | | | |
| 27 | 3 | 5.40 | My Choice | do | 9 | | | 6 | | | 9 |
| 28 | 4 | 5.30 | Jack Frost | Up | 13½ | 12 | | | 9 | | 10½ |
| 29 | 5 | 5.20 | Gen. Gillmore | Down | 12 | | 6½ | | | | |
| 30 | 6 | 4.80 | Arkansas City | do | | | | | | | |
| 31 | 8 | 4.60 | City of Providence | do | | | 5½ | 5½ | | | |
| 32 | 9 | 4.30 | City of Hickman | do | 9 | | | | | 9 | |
| 33 | 12 | 4.40 | Gen. Gillmore | do | 9 | | 6 | | | 9 | 16½ |
| 34 | 14 | 5.00 | My Choice | do | | | | 6½ | | | |
| 35 | 15 | 4.70 | City of Cairo | do | | | | | | | |
| 36 | 15 | 4.70 | City of St. Louis | do | 10½ | | 7½ | | | | 10½ |
| 37 | 19 | 4.00 | Gen. Gillmore | do | 9 | | 5 | | | | 13½ |
| 38 | 20 | 3.90 | State of Kansas | do | | | | | | | |
| 39 | 20 | 3.90 | Arkansas City | do | | | | 6 | | 8 | |
| 40 | 22 | 3.70 | Gen. Gillmore | do | | | | | | 8 | |
| 41 | 27 | 3.16 | City of Providence | do | | | | 5 | | | |
| 42 | 28 | 3.00 | A. L. Mason | do | | | | | | | |
| 43 | 29 | Gauge covered with mud. | Gen. Gillmore | do | 9 | | 7 | | | 8½ | 15 |
| 44 | 30 | | do | do | | | | | | | |
| 45 | 30 | | City of Hickman | do | 9 | | | | | 7½ | |
| 46 | Oct. 3 | 2.70 | Gen. Gillmore | do | 8 | | 5 | 7½ | | | |
| 47 | 7 | 2.00 | do | do | | | | | | | |
| 48 | 7 | 2.00 | Paul Tulane | do | | | | | | | |
| 49 | 8 | 1.80 | State of Kansas | do | 7 | | | 8 | | | 9 |
| 50 | 10 | 1.60 | Gen. Gillmore | do | 8 | | 4½ | 7½ | | | |
| 51 | 11 | 1.50 | do | do | | | | | | | |
| 52 | 13 | 1.20 | War Eagle | do | | | | 4½ | | | 8 |
| 53 | 17 | 1.30 | Gen. Gillmore | do | 7 | | 4 | 6 | | 7 | |
| 54 | 18 | 1.00 | do | do | | | | | | | |
| 55 | 25 | 1.00 | Grey Eagle | do | | | | 5 | | | |
| 56 | 27 | 1.10 | Gen. Gillmore | do | 7 | | 4½ | 7 | | | |
| 57 | 31 | 2.10 | do | do | 8½ | | 5 | 7½ | | | |
| 58 | Nov. 7 | 1.30 | do | do | 7 | | 5 | 6 | | 8 | |
| 59 | 10 | 1.00 | do | do | | | | | | | |
| 60 | 14 | 1.00 | do | do | 7½ | | 4 | 7 | | 6½ | |
| 61 | 21 | 1.10 | do | do | 7½ | | 4½ | | | 6½ | |
| 62 | Dec. 14 | 1.40 | Grey Eagle | do | | | | | | | |
| | 1893. | | | | | | | | | | |
| 63 | Feb. 16 | 4.00 | My Choice | do | | | | 9 | | 5½ | |
| 64 | 22 | 5.40 | City of New Orleans | do | | | | 9½ | | | |
| 65 | Mch. 1 | 8.00 | City of Hickman | do | | | | 10½ | | | |
| 66 | 29 | 14.00 | City of St. Louis | do | | | | | | | |
| 67 | Apr. 1 | 13.00 | Arkansas City | do | | | | | | | |
| 68 | 2 | 12.70 | Hy. Lowry | Up | | | | | | | |
| 69 | 7 | 12.40 | City of New Orleans | Down | | | | 15 | | | |
| 70 | 8 | 12.50 | H. M. Hoxie | Up | | | | 15 | | | 18 |
| 71 | 10 | 12.80 | Hy. Lowry | Down | | | | 13½ | | | 15 |
| 72 | 10 | 12.80 | City of Vicksburg | do | | | | 15 | | | |
| 73 | May 20 | | H. M. Hoxie | do | | | | | | | 16½ |
| 74 | June 7 | 22.00 | do | do | | | | | | | 16½ |
| 75 | 18 | 16.90 | do | do | | | | 22½ | | 12 | 16½ |
| 76 | 21 | 14.60 | City of St. Louis | do | | | | | | | |
| 77 | 21 | 14.60 | City of Hickman | do | | | | | | | |

***bars between St. Louis and Cairo.***

| Harrisonville. | Lucas. | Herculaneum. | Swashin. | Calico Island. | Cornice Island. | Forest Home Landing. | Perry Tow Head. | Bush Tow Head. | Salt Lake Landing. | Brickey Mill. | Fort Chartres Landing. | Crookes Landing. | Stantons Landing. | St. Genevieve. | Moro Island. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | |
| | 21 | | | | | | 18 | | 16½ | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | 16½ | | | | | 12 | |
| | | | | | | | | | | | | | | 18 | |
| 15 | | | | | | 16½ | 16 | | | | 13½ | | | | |
| | 18 | | | | | | | | | | 16½ | | 12 | | |
| | 21 | | | | | 19½ | | | 8½ | | | | | | |
| 16½ | | | | | | 29 | 10½ | | | | 9½ | | | | |
| | | | | | 18 | 12 | 9½ | | | | 9½ | | | | |
| | | | | | | 12 | 10½ | | | | 10½ | | | 12 | |
| 15 | | | | | | 13½ | | | | | 8½ | | | | |
| | | | | | | | 9 | | | | 7 | | | 7 | |
| 15 | | | | | 13½ | 10½ | | 12 | | 7 | | | 18 | | |
| | | | | | | | | | | | | | | | |
| | | | | | 15 | 16½ | 9 | | | | 8 | | | | |
| 12 | | | | | 12 | 12 | 8 | | | | 7½ | | | 13½ | |
| | | | | | | | | | | | 8 | | | | |
| | | | | | 12 | 12 | 8 | 12 | | | 7 | | | 7½ | |
| 9 | | | | | 12 | 10½ | 8 | | | | 7 | | | | |
| 15 | | | | | 13 | 12 | 9½ | | | | 8 | | | | |
| | | | | | | 9½ | 10½ | | | | 7½ | | | 8 | |
| | | | 10½ | | 12 | | 8½ | 12 | | | 7 | | 8 | | |
| | | | | | | | | | | | | | | | |
| | | | 8 | | 8½ | 9 | 8½ | 8½ | | | 6½ | | | 10½ | |
| | | | 8 | | 8 | 9 | 8½ | 8½ | | | 6 | | | 10 | |
| | | | | | | | 10½ | | | | 8 | | | | |
| | | | | | 13½ | | | | | 7 | | 16½ | | 7 | 8 |
| | | | | | | | 12 | | | | 7 | | | 6 | |
| | | | 7½ | | | | 8 | | | | 6½ | | | 8½ | 10½ |
| 10½ | | | 7 | | 6 | 12 | | 9 | | | | | | | |
| 5 | | | | | | 8 | | | | | 5 | | | | |
| | | | | | 10½ | | 10½ | 8 | | | 7 | | | 7½ | |
| | | | | | 10½ | 9 | | | | | 6½ | | | | |
| | | | | | 9 | | | | | | 8 | | | | |
| | | 7½ | | | | | 7 | | | | 6½ | | | 7 | |
| 9½ | | | | | 8½ | | 9½ | | | | | | | 6 | |
| 8 | | | | | 9 | 9 | 8 | | | | 5½ | | 6 | | |
| 10½ | | | | | | | 9 | | | | 5½ | | | | 7 |
| | | | | | | | | | | | 6 | | | | |
| | | | | | | 8 | | | | | 5½ | | | | |
| | | | | | | | | | | | 6 | | 5½ | | 7 |
| 9 | | | | | 10½ | | | 8 | | | 5½ | | | 7 | |
| | | | | | | | | | | | | | | | |
| | | | 6 | | | 10½ | 8½ | | | | 5 | | 9 | | |
| 9 | | | | | 9 | | 9½ | | | | 6 | | | 6 | |
| | | | | | | | | | | | | | | | |
| | | | 5½ | | | | | | | | | | | 5½ | |
| 6½ | | | 6 | | 9 | | | | | | 5 | | | 5 | |
| 8 | | | | | | | 10½ | | | | 5 | | | 6 | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | 4½ | | | | |
| 6½ | | | | | | | 8 | | | | 4 | | | | |
| | | | | | | | | | | | | | | 6 | |
| | | | | | | | | | | | 4½ | | 5 | | |
| | | | | | | | | | | | 5½ | | | 5½ | |
| | | | | | | | 12 | | | | 5 | | | | |
| 8 | | | | | | | | | | | | | | | |
| | | | | | | | 9 | | | | 4½ | | | | |
| 7 | | | | | | | 10½ | | | | 4 | | | | |
| 8 | | | | | | | 9 | | | | 4 | | | | |
| | | | | | | | | | | | | | | | |
| | | | 7 | | | | | | | | 5½ | | | | |
| | | | | | | | | | | 9 | | | | 7 | |
| | | | | | | | | | | | 9 | | 12 | | |
| | | | | | | | | | | | | | | 16½ | |
| | | | | | | | | | | | 10½ | | | | |
| | | | | | 18 | | 16½ | | | | 16½ | | | | |
| | | | | | | | | | | | 10½ | | | | |
| | | | 16½ | | 16½ | 16½ | 15 | | | | 13½ | | | | |
| | | | 13½ | | | 15 | | | | | 9½ | | | 13½ | |
| | | | | | | | | | | 12 | | | 13 | | |
| | 16½ | | | | | 18 | | | | | 18 | | | 10½ | |
| | | | | | | 21 | | | | | 16½ | | | 16½ | |
| | 15 | | | | | 16½ | 18 | | | | 15 | | | | |
| | | | 13½ | | | | | | | | 10½ | | | 16½ | |
| | | | | | | 15 | | | | | 13½ | | | | |

*Depth of water in feet upon the*

| Number of trips. | Date. | Stage above standard low water by St. Louis gauge. | Name of steamer furnishing report. | Direction. | St. Genevieve County. | Blocks. | Manscoes. | Liberty Island. | Crawfords Landing. | Neelys Landing. | Bainbridge. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1892. | *Feet.* | | | | | | | | | |
| 1 | July 2 | 24.50 | City of New Orleans | Down | | | | | | | |
| 2 | 12 | 26.40 | City of Providence | do | | | | | | | |
| 3 | 16 | 25.60 | City of St. Louis | do | | | | | | | |
| 4 | 17 | 25.20 | H. M. Hoxie | do | | 24 | | 24 | | | |
| 5 | 21 | 23.20 | City of New Orleans | do | | | | | | | |
| 6 | 27 | 18.90 | City of Hickman | do | 12 | 13½ | 19½ | 18 | | | |
| 7 | 27 | 18.90 | City of Providence | do | | 13½ | | | | | |
| 8 | 29 | 16.50 | City of Monroe | do | | 15 | 15 | 15 | | | |
| 9 | 31 | 15.20 | Sidney Dillon | do | 9 | 9 | 13½ | 13½ | | | |
| 10 | Aug. 1 | 14.80 | H. M. Hoxie | Up | 8½ | 13½ | | 12 | 12 | 19½ | 18 |
| 11 | 3 | 13.50 | City of Cairo | Down | | | | | | | |
| 12 | 5 | 12.50 | Arkansas City | do | | | 15 | 13½ | | | |
| 13 | 9 | 10.80 | Gen. Gillmore | do | | | | | | | |
| 14 | 10 | 10.40 | City of New Orleans | do | | 9 | | 15 | | | |
| 15 | 12 | 60.00 | City of Monroe | do | 9½ | 8 | 15 | 10½ | | | |
| 16 | 12 | 60.00 | do | do | | | | | | | |
| 17 | 14 | 60.10 | S. H. H. Clark | do | | 8 | 12 | 9 | | | |
| 18 | 15 | 9.40 | Gen. Gillmore | do | | | | | | | |
| 19 | 16 | 9.10 | City of Cairo | do | | 8 | 15 | 10½ | | | |
| 20 | 17 | 8.90 | City of Hickman | do | 9 | 8½ | 13½ | 10½ | | | |
| 21 | 18 | 8.50 | City of Providence | do | 9 | 9 | 12 | 12 | | | |
| 22 | 22 | 7.40 | Gen. Gillmore | do | | | | | | | |
| 23 | 22 | 7.40 | Arkansas City | do | 12 | | | 9½ | | | |
| 24 | 30 | 5.50 | City of Cairo | do | | | | | | | |
| 25 | 30 | 5.50 | Jay Gould | do | | 6 | 9½ | 6½ | 6½ | | |
| 26 | Sept. 1 | 5.60 | Gen. Gillmore | do | | | | | | | |
| 27 | 3 | 5.40 | My Choice | do | | 6 | 9 | | 9 | 8 | |
| 28 | 4 | 5.30 | Jack Frost | Up | | | 9 | | 9½ | | |
| 29 | 5 | 5.20 | Gen. Gillmore | Down | | | | | | | |
| 30 | 6 | 4.80 | Arkansas City | do | | | | | | | |
| 31 | 8 | 4.60 | City of Providence | do | | 6 | 8 | 8 | 8 | 8 | |
| 32 | 9 | 4.30 | City of Hickman | do | 9 | 6 | | 8½ | 7½ | 8 | |
| 33 | 12 | 4.40 | Gen. Gillmore | do | | | | | | | |
| 34 | 14 | 5.00 | My Choice | do | | 5½ | | | 9 | 8½ | |
| 35 | 15 | 4.70 | City of Cairo | do | | | | | | | |
| 36 | 15 | 4.70 | City of St. Louis | do | | 7 | 7½ | 8 | 8 | | |
| 37 | 19 | 4.00 | Gen. Gillmore | do | | | | | | | |
| 38 | 20 | 3.90 | State of Kansas | do | | 6 | 8 | 8 | 6 | | |
| 39 | 20 | 3.90 | Arkansas City | do | | 6 | 8 | | | | |
| 40 | 22 | 3.70 | Gen. Gillmore | do | | | | | | | |
| 41 | 27 | 3.10 | City of Providence | do | | | 8 | | 8 | | |
| 42 | 28 | 3.00 | A. L. Mason | do | | 6 | | | | | |
| 43 | 29 | Gauge covered with mud. | Gen. Gillmore | do | | | | | | | |
| 44 | 30 | | do | do | | 5 | 8½ | 8 | | | |
| 45 | 30 | | City of Hickman | do | | 5½ | 7½ | 8 | 7½ | | |
| 46 | Oct. 3 | 2.70 | Gen. Gilmore | do | | | | | | | |
| 47 | 7 | 2.00 | do | do | | 5 | 7 | 6 | | | |
| 48 | 7 | 2.00 | Paul Tulane | do | | | | | | | |
| 49 | 8 | 1.80 | State of Kansas | do | | 5 | | 6 | 7 | 8 | |
| 50 | 10 | 1.60 | Gen. Gilmore | do | | | | | | | |
| 51 | 11 | 1.50 | do | do | | 5 | | | | | |
| 52 | 13 | 1.20 | War Eagle | do | 5 | | 8 | 8 | | | |
| 53 | 17 | 1.30 | Gen. Gilmore | do | | | | | | | |
| 54 | 18 | 1.00 | do | do | | | | | | | |
| 55 | 25 | 1.00 | Grey Eagle | do | 5 | 5 | | | | | |
| 56 | 27 | 1.10 | Gen. Gilmore | do | | | | | | | |
| 57 | 31 | 2.10 | do | do | | | | | | | |
| 58 | Nov. 7 | 1.30 | do | do | | | | | | | |
| 59 | 10 | 1.00 | do | do | 5½ | | | | | | |
| 60 | 14 | 1.00 | do | do | | | | | | | |
| 61 | 21 | 1.10 | do | do | | | | | | | |
| 62 | Dec. 14 | 1.40 | Grey Eagle | do | | | | | | | |
| | 1893. | | | | | | | | | | |
| 63 | Feb. 16 | 4.00 | My Choice | do | | 6 | | | | | |
| 64 | 22 | 5.40 | City of New Orleans | do | | | | | | | |
| 65 | Mar. 1 | 8.00 | City of Hickman | do | | 12 | | 9 | | | |
| 66 | 29 | 14.00 | City of St. Louis | do | | | | | | | |
| 67 | Apr. 1 | 13.00 | Arkansas City | do | | 15 | | | | | |
| 68 | 2 | 12.70 | Hy. Lowry | Up | 16½ | | | | | | |
| 69 | 7 | 12.40 | City of New Orleans | Down | | 12 | | 15 | | | |
| 70 | 8 | 12.50 | H. M. Hoxie | Up | 13½ | 12 | 16½ | 12 | | | |
| 71 | 10 | 12.80 | Hy. Lowry | Down | | 15 | 13½ | 10½ | 15 | | |
| 72 | 10 | 12.80 | City of Vicksburg | do | | | | | | | |
| 73 | May 20 | | H. M. Hoxie | do | | 10½ | | | | | |
| 74 | June 7 | 22.00 | do | do | | 15 | | | | | |
| 75 | 18 | 16.90 | do | do | 15 | 12 | 21 | 13½ | 19½ | 18 | |
| 76 | 21 | 14.60 | City of St. Louis | do | | | 18 | | | | |
| 77 | 21 | 14.60 | City of Hickman | do | | 12 | | | | | |

*bars between St. Louis and Cairo*—Continued.

| Scheinemans. | Kinney Point. | Devils Island. | Cape Girardeau. | Jacket Pattern. | Athertons Landing. | Goose Island. | Hackers Bend. | Saladin. | Buffalo Island. | Brewers Point. | Scudder Tow Head. | Stannards. | Greenleafs Landing. | Eliza Point. | Greenfields. | Cairo Point. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 16½ | | | | 16½ | | | | | | |
| | | | | | | | | | 21 | 18 | | 16½ | | | | |
| | | | | | | | | | | | | | 19½ | | | |
| | | 16½ | | | | 16½ | | | 15 | | | | | | | |
| | | | | | | 16½ | | | 18 | | | | 12 | | | |
| | | 10½ | | 15 | | 10 | 15 | | | | | 18 | 10 | | | |
| | | | | | | 9½ | | | | | | 10½ | 7½ | 12 | | |
| | | 10½ | | 10½ | | 10½ | | | 10½ | | | 13½ | | | | |
| | | 15 | | 12 | | 10½ | | | 8½ | | | 10½ | 10½ | | 9 | |
| | | 9½ | | 13 | | 8 | 12 | | | | | | 7½ | | | |
| | | 8½ | | 13½ | | 12 | 10½ | | | | | 10½ | 7½ | | | |
| 8½ | | | | 15 | | 9½ | 9½ | | | | | | 6½ | | | |
| | | | | | | | | | | | | | | | | |
| | | 7 | | 12 | | 8 | | | 8 | | | 8 | 9 | | | |
| | | 6½ | | | | 8 | 8 | | | 8 | | 7 | | | 12 | |
| | | | | | | | | | | | | | | | | |
| | | | | | | 10 | | | 7½ | 7½ | | | 8 | | | |
| | | | | | | | | | | | | | | | | |
| | | 8 | | | | 9 | 9 | | | | 7½ | 9 | 7½ | | | |
| | | | | 9 | | 7 | 7 | | | | 6½ | | | 10½ | | |
| 8 | | | | | | 9 | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| | | 13½ | | 12 | | 8 | | | | | 7 | | 8 | | 10½ | |
| | | 7 | | | | | | | | | | | 6½ | | | |
| | | 6 | | 6 | | 8 | 5½ | | | | | | 6 | 9 | 6½ | |
| | | | | | | | | 5½ | | | | | | | | |
| | | 6 | 5 | 9 | | 7 | 6 | | | | | | | | | |
| | | 8 | | 8½ | 7 | | 6½ | | | | | 9 | | 6½ | | 9 |
| | | | | | | | | | | | | | | | | |
| | | 5½ | | 9½ | | 7 | 7½ | | | | | | 7 | | | |
| | | 6 | | 7 | 7 | | | 9 | 5½ | | | | 7 | | | |
| | | 6 | | 7½ | | 6½ | 5 | | | | | 8 | 6½ | 6½ | | |
| | | | | | | | | | | | | | | | | |
| | | 6½ | | 8 | | 7½ | | | 7 | | | | 6 | | | |
| | | 7½ | | | | | | | 6½ | | | | 6½ | | | |
| | | 6 | | | | 7½ | | | 7 | | | | 7 | | 8 | |
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| | | 6 | | 9 | | 6½ | | | 6 | | | | 7 | | 6½ | |
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| | | 9 | | 6½ | | 6 | | | 6½ | | | | | | | |
| | | 6 | | 7 | | 6½ | | | 6½ | | | | | 8 | | |
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| | 4 | 8 | | 8 | | | | | 6½ | 6 | | | | 8 | | |
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| | | 5½ | | 7 | | 5½ | | | | | | | 6 | | | |
| | | 5½ | | 6 | | 5½ | | | | | | | 5½ | 6½ | | |
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| | | 6 | | 6½ | | 5½ | | | 6 | | | | 6 | 6 | | |
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| | | 9½ | | | | | | | | | | | 15 | | | |
| | | 9½ | | 12 | | | | | | | 13½ | | | | | |
| | | 16½ | | 10½ | | 16½ | | | | | 12 | 18 | 13½ | 24 | | |
| | | 12 | | 10½ | | | | | | 12 | | | | | | |
| | | 10½ | | 13½ | | | | | | | | | 12 | | | 13½ |
| | | 10½ | | | | 13½ | | | | | | 15 | 12 | 16½ | | |
| | | 13½ | 13½ | 13½ | | | | | | 12 | | | 12 | | | |
| | | 18 | | | | | | | | | | | | | | |
| | | 21 | | | | | | | 21 | | | | | | 21 | |
| | | 16½ | | 13½ | | 18 | 10½ | | | | | | | | 8½ | 13½ |
| | | 16½ | | | | | | | | | | | 9 | | | |
| | | 10½ | | | | | | | | | | | | | | |

## COMMERCIAL STATISTICS.

*Receipts and shipments at St. Louis, Mo., during the years 1889, 1890, 1891, 1892.*

| Articles. | Receipts. | | | |
|---|---|---|---|---|
| | 1889. | 1890. | 1891. | 1892. |
| | *Tons.* | *Tons.* | *Tons.* | *Tons.* |
| Barbed wire and ores and metals (pig and manufactured) | 31,663 | 21,782 | 13,741 | 16,768 |
| Cement | 6,876 | 15,892 | 18,621 | 1,238 |
| Coal and coke | 88,845 | 81,565 | 55,980 | 85,547 |
| Cotton (and products) | 4,663 | 4,230 | 2,946 | 1,462 |
| Groceries and dairy products | 8,815 | 8,262 | 7,604 | 18,382 |
| Hay, seeds, and grain (including flour, meals, etc.) | 96,265 | 92,914 | 96,526 | 76,376 |
| Jute | 3,473 | 235 | | |
| Live stock and products | 12,805 | 17,347 | 15,217 | 14,953 |
| Lumber | 127,695 | 132,940 | 142,090 | 159,140 |
| Merchandise and sundries | 281,579 | 284,589 | 234,817 | 310,370 |
| Vegetables | 7,986 | 3,530 | 4,110 | 2,559 |
| White lead, oils, etc | 756 | 204 | 63 | 12 |
| Wines and liquors | 102 | 60 | 121 | 64 |
| Wool | 162 | 180 | 304 | 329 |
| Total | 671,685 | 663,780 | 592,140 | 687,290 |

| Articles. | Shipments. | | | |
|---|---|---|---|---|
| | 1889. | 1890. | 1891. | 1892. |
| | *Tons.* | *Tons.* | *Tons.* | *Tons.* |
| Barbed wire and ores and metals (pig and manufactured) | 5,885 | 3,945 | 4,802 | 3,574 |
| Cement | | | | |
| Coal and coke | 1,701 | 734 | 148 | 10,504 |
| Cotton (and products) | 200 | 527 | 38 | 22 |
| Groceries and dairy products | 8,047 | 7,428 | 9,675 | 13,919 |
| Hay, seeds, and grain (including flour, meals, etc.) | 538,329 | 440,728 | 377,416 | 314,336 |
| Jute | | | | |
| Live stock and products | 15,429 | 18,379 | 15,166 | 10,040 |
| Lumber | 6,470 | 8,526 | 6,245 | 7,000 |
| Merchandise and sundries | 131,546 | 117,806 | 95,842 | 138,250 |
| Vegetables | 2,612 | 1,739 | 1,435 | 2,132 |
| White lead, oils, etc | 1,799 | 1,379 | 1,555 | 1,786 |
| Wines and liquors | 647 | 668 | 590 | 631 |
| Wool | 35 | 3 | 18 | 21 |
| Total | 712,700 | 601,862 | 512,930 | 502,215 |

*Transferred by ferries across the river at St. Louis.*

| | Tons. |
|---|---|
| 1889 | 2,717,760 |
| 1890 | 3,052,166 |
| 1891 | 3,268,753 |
| 1892 | 2,760,187 |

*Shipments down the river from landings between St. Louis and Cairo during the years 1889-'92.*

Grain, including flour, meals, etc.:

| | Tons. |
|---|---|
| 1889 | 29,209 |
| 1890 | 34,267 |
| 1891 | 20,353 |
| 1892 | 18,990 |

### RECAPITULATION.

| | 1889. | 1890. | 1891. | 1892. |
|---|---|---|---|---|
| | *Tons.* | *Tons.* | *Tons.* | *Tons.* |
| Receipts and shipments at St. Louis | 1,384,385 | 1,265,592 | 1,105,070 | 1,189,415 |
| Transferred by ferries at St. Louis | 2,717,760 | 3,052,166 | 3,268,753 | 2,760,187 |
| Shipped from landings between St. Louis and Cairo | 29,209 | 34,267 | 20,353 | 18,990 |
| Total | 4,131,354 | 4,352,025 | 4,394,176 | 3,968,592 |

*List of steam power boats that arrived at St. Louis during the year 1892.*

| Size of boats. | Draft. | Boats. | Times arrived. |
|---|---|---|---|
| | *Feet.* | | |
| Under 500 gross tons | 3 to 6.5 | 80 | 1,067 |
| Between 500 and 1,000 gross tons | 4 7.2 | 25 | 1,294 |
| Over 1,000 gross tons | 6 9.5 | 13 | 301 |
| Tonnage and size unknown | | 7 | 16 |
| Total | | 125 | 2,678 |

*List of barges and scows that arrived at St. Louis during the year 1892.*

| Sizes of barges, etc. | Draft. | Barges and scows. | Times arrived. |
|---|---|---|---|
| | *Feet.* | | |
| Under 500 tons | 3.5 to 8 | 28 | 184 |
| Between 500 and 1,000 tons | 5.2 8 | 19 | 69 |
| Over 1,000 tons | 5.3 9 | 68 | 306 |
| Tonnage and size unknown | | 271 | 547 |
| Total | | 386 | 1,106 |

*List of steamers and barges permanently and temporarily enrolled at the port of St. Louis on December 31, 1892.*

| | Vessels. | Gross tonnage. | Net tonnage. |
|---|---|---|---|
| Permanently enrolled steam (wood) | 101 | 41,080.83 | 40,419.55 |
| Permanently enrolled barges (wood) | 89 | 87,542.09 | 87,451.25 |
| Permanently enrolled steam (iron) | 4 | 1,690.29 | 1,667.09 |
| Temporarily enrolled steam (wood) | 2 | 82.44 | 80.50 |
| Permanently licensed steam, under 20 tons | 8 | 143.27 | 115.80 |
| Temporarily licensed steam, under 20 tons | 1 | 24.12 | 13.23 |
| Barges licensed, under 20 tons | 5 | 48.71 | 48.71 |
| Grand total | 210 | 130,611.75 | 129,796.13 |

## Y 3.

## IMPROVEMENT OF HARBOR AT ST. LOUIS, MO.

St. Louis Harbor has a length of about 18 miles, being divided into two nearly equal parts by the Eads Bridge. The upper portion of the harbor, between this bridge and the northern limits of the city, is about 10 miles in length. About 3 miles above the Eads Bridge is the Merchants Bridge. The lower portion of the harbor, included between the Eads Bridge and River Des Peres, is 8 miles long. A good depth of water and accessible landings exist in this lower part of the harbor, and a sufficient depth is found above the Merchants Bridge. Between the Merchants and Eads bridges, however, there existed middle bars, and also shoals near the Illinois shore, which interfered with navigation.

Appropriations for improvement of St. Louis Harbor had been made as early as 1836, and a longitudinal stone dike was built at that time near the head of the present works by Capt. R. E. Lee, Corps of Engineers. Other work, done in later years by the United States, consisted in the building of stone and brush dikes, generally normal to the direction of the current, in the closing of Cahokia Chute, and protection of the bank in Sawyer Bend.

The river and harbor act of Congress, approved September 19, 1890, contained an appropriation of $182,000 for improving harbor at St. Louis, Mo., and the officer in charge, in submitting a project for its expenditure, recommended that the money be applied to the portion of the harbor between the Eads and Merchants bridges. The approved project consisted in the contraction of the river by a system of hurdles along the Illinois shore for a distance of 13,000 feet to a width of 2,000 feet, with a view to removing the bars which then existed and which interfered with navigation at low stages of the river, and also to improve the ferry landings on the Illinois shore. The object of the hurdles was to cause deposits of sediment, and thus build up a new bank out to the line desired.

The hurdles were all completed by July 1, 1892. Extensive deposits have occurred along the line of hurdles, and the work has already resulted in a considerable increase in channel depth, with corresponding benefit to navigation.

Amount expended to July 1, 1892, $150,530.21.

No money was expended upon this improvement during the past fiscal year.

No further appropriation is needed for this work.

With the balance ($31,469.79) remaining from the appropriation of 1890 it is proposed to repair damage that may occur to the hurdles from ice and drift and to extend them whenever found necessary to do so.

The commercial statistics will be found in the report on improvement of the Mississippi River between the Ohio and Missouri rivers.

*Appropriations made by Congress for improvement of harbor at St. Louis, Mo.*

| | |
|---|---|
| By act of September 19, 1890 | $182,000.00 |

*Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $31,469.79 |
| July 1, 1893, balance unexpended | 31,469.79 |
| July 1, 1893, outstanding liabilities | 230.04 |
| July 1, 1893, balance available | 31,239.75 |

## Y 4.

### IMPROVEMENT OF GASCONADE RIVER, MISSOURI.

The navigation of this stream, before its improvement was undertaken by the Government, was seriously obstructed by snags, logs, and leaning timber, and at times almost suspended on account of numerous shoal crossings. Snags are liable to be found after every flood, which also carries more or less drift; the latter is apt to be deposited at the shoals or at other points, causing trouble to rafts and steamers.

Improvement by the Government commenced in 1880, and the project which was adopted consisted in the removal of snags and logs from the channels and of leaning timber from the banks of the river, where necessary, and in construction of wing dams and training walls to concentrate the flow of water upon the shoals, and thus increase the depth over them.

The estimated cost of the improvement was $50,000, but as new obstructions are continually forming, it will require appropriations from time to time to keep the channel open at low water after the principal work has been done. (Please see page 1740, Appendix X to Annual Report, 1892, lines 21–24 from top of page.)

Amount expended to July 1, 1892, $44,689.51, which resulted in putting the river from its mouth to Arlington, 138 miles, in good navigable condition, but the high water of that year carried many snags into the river that afterwards had to be removed.

The operations for the past fiscal year consisted in removing channel and bank obstructions from the mouth of the river to the head of Pryors Mill Chute, and in constructing and repairing dams at that chute, Bocks Bar, Hensleys Shoal, and at Peckerwood. The work was done by hired labor.

Amount expended during the fiscal year ending June 30, 1893, $2,949.89, resulting in further benefit to navigation.

The details of the work are given in the report herewith, of Mr. J. W. Beaman, Assistant Engineer.

It is proposed to expend the balance of the funds remaining on hand in continuing removal of obstructions, carrying the work upstream.

The sum of $10,000 can be profitably expended during the fiscal year ending June 30, 1895, in continuing removal of obstructions, and in repairing and building wing dams.

The commerce of the river is given in tables of statistics herewith:

*Appropriations made by Congress for improving Gasconade River, Missouri.*

| | |
|---|---|
| By act of— | |
| June 14, 1880 | $5,500 |
| March 3, 1881 | 10,000 |
| August 2, 1882 | 10,000 |
| July 5, 1884 | 5,000 |
| August 5, 1886 | 7,500 |
| August 11, 1888 | 5,000 |
| September 19, 1890 | 4,000 |
| July 13, 1892 | 4,000 |
| Total | 50,500 |

*Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $1,810.49 |
| Amount appropriated by act approved July 13, 1892 | 4,000.00 |
| | 5,810.49 |
| June 30, 1893, amount expended during fiscal year | 2,949.89 |
| July 1, 1893, balance unexpended | 2,860.60 |
| July 1, 1893, outstanding liabilities | 353.25 |
| July 1, 1893, balance available | 2,507.35 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895 | 10,000.00 |
| Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893. | |

## REPORT OF MR. J. W. BEAMAN, ASSISTANT ENGINEER.

JEFFERSON CITY, MO., *June 30, 1893.*

MAJOR: I have the honor to submit the following report upon the improvement of the Gasconade River, Missouri, for the fiscal year ending June 30, 1893:

Improvement work on the Gasconade River during the past year has included the removal of channel and bank obstructions to steamboat and raft navigation; the contraction of waterway by means of crib dams at the head of Pryors Mill Chute; the contraction of the waterway at Hensleys Shoal by two crib dams, one above, the other below, the old ford road across the right chute; and the repair of the cross dams at Peckerwood and Bocks Bar shoals.

*Snagging, etc.*—During the month of July one man was employed in felling the overhanging timber between the mouth of the river and Pryors Mill, a distance of 30 miles.

On August 1, in conformity with the instructions of your predecessor, Maj. A. M. Miller, United States Engineer, by letter of July 16, 1892, a party was organized for the removal of channel and bank obstructions, and for the construction of contraction works at points where the river had become especially troublesome at low-water stages on account of excessive width of stream.

The working party organized was a small one, consisting of a foreman and seven men.

The improvement plant included two dog boats, each 16 feet by 4 feet by 16 inches; a flat boat, 20 feet by 8 feet by 18 inches; a crab, blocks, ropes, and tools necessary for the work.

A team of horses, hired by the month, furnished the power necessary to work the crab.

The party was organized at Gasconade City, and the snagging operations were begun at the mouth and were carried on up the river to a point 1 mile above the head of Pryor's Mill Chute.

Work ceased for the winter on December 15 and was resumed on May 1 at Pryors Bend, in accordance with your letter of instructions of April 28.

The following tabulated statement will indicate the work done during the year:

*Snagging, etc., July 1 to December 15, inclusive.*

| | |
|---|---:|
| Snags removed from the channel | 173 |
| Drift piles removed from channel | 3 |
| Overhanging trees felled | 98 |
| Miles of river worked | 31 |

*Snagging, etc., May 1 to June 30, inclusive.*

| | |
|---|---:|
| Snags removed from the channel | 73 |
| Overhanging trees felled | 52 |
| Drift trees cut up | 33 |
| Drift piles removed | 3 |

*Construction and repair of dams.*—The work of construction and repair of contraction works for the year may be tabulated as follows:

*Work done at Pryor's Mill Chute, August 8 to November 9, inclusive.*

| | |
|---|---:|
| Linear feet of dam built | 228 |
| Cubic yards of rock quarried and placed | 496 |
| Linear feet of logs 9 inches in diameter built into dam | 1,772 |
| Cribs 20 by 9 feet built | 10 |
| Piles 4 inches by 6 feet cut and driven | 26 |

*Work done at Bocks Bar, September 7 to 16, inclusive.*

| | |
|---|---:|
| Linear feet of cross dam rebuilt | 43 |
| Cubic yards of rock deposited in cross dam | 198 |
| Piles 3 inches by 6 feet cut and driven | 43 |

*Work done at Hensleys Shoal, October 20 to December 2, inclusive.*

| | |
|---|---:|
| Linear feet of dam built | 177 |
| Cubic yards of rock quarried and placed | 170 |
| Cubic yards of gravel placed | 26 |
| Cubic yards of brush placed | 61 |
| Piles 3 inches by 6 feet cut and driven | 141 |
| Linear feet of logs 9 inches diameter cut and placed | 952 |
| Cribs 20 by 6 feet built | 8 |

*Work done at Peckerwood, December 5 to 13, inclusive.*

| | |
|---|---|
| Linear feet of dam built | 47 |
| Linear feet of logs 9 inches in diameter placed | 281 |
| Cribs 20 by 6 feet built | 1 |
| Piles 3 by 6 feet cut and driven | 35 |
| Cubic yards of rock quarried and placed | 88 |

The crests of the dams at Pryor's Mill and Hensleys Shoal were built to a plane 2 feet above low water, and a clear waterway 94 feet wide and 7 feet deep was left at the head of Pryor's Mill Chute.

### RECAPITULATION OF THE YEAR'S WORK.

*Construction.*

| | |
|---|---|
| Number of linear feet of crib and stone dam built | 595 |
| Number of cubic yards of rock quarried | 754 |
| Number of cubic yards of rock boated and placed | 952 |
| Number of cubic yards of gravel placed | 26 |
| Cubic yards of brush placed | 61 |
| Linear feet of logs cut and placed | 3,005 |
| Cribs 20 by 9 feet built | 16 |
| Cribs 20 by 6 feet built | 9 |
| Piles cut and driven | 210 |
| New dams built | 3 |
| Old dams repaired | 2 |

*Snagging, etc.*

| | |
|---|---|
| Snags removed from the channel | 246 |
| Drift piles removed from the channel | 6 |
| Trees felled | 150 |
| Miles of river worked | 31 |

*Projected work.*—Every high stage of the river carries drift, some of which it may be expected will be deposited at the shoals, or at other points, so as to cause trouble to rafts or steamboats.

For the removal of snags, and for the repair of old or for the building of new dams, $10,000, in addition to the balance on hand, should be available for the improvement of the river between Arlington and the mouth—upwards of 138 miles of river line.

The commerce of the river is of such value as to warrant this provision.

Shoals where contraction works are most needed at present are Stake, Sand, Diving and Perkins.

I have the honor to be, very respectfully, your obedient servant,

J. W. BEAMAN,
*Assistant Engineer.*

Maj. CHAS. J. ALLEN,
*Corps of Engineers, U. S. A.*

### COMMERCIAL STATISTICS, GASCONADE RIVER, MISSOURI.

| Articles. | 1890. | 1891. | 1892. |
|---|---|---|---|
| | *Tons.* | *Tons.* | *Tons.* |
| Hay, grain, seeds, etc | 2,658 | 4,035 | 1,547 |
| Lumber, logs, wood, railway ties, etc | 22,806 | 19,646 | 10,626 |
| Live stock | 209 | 425 | 416 |
| Produce | 5 | 67 | 80 |
| Salt | 28 | 29 | 23 |
| Iron, nails, etc | 23 | 3 | 4 |
| Farm machinery | 115 | 87 | 30 |
| General merchandise | 239 | 216 | 203 |
| Total | 26,083 | 24,458 | 12,929 |

*List of steam-power boats engaged in commerce on the Gasconade River during the year 1892.*

| Name. | Length. | Breadth. | Depth. | Gross tonnage. |
|---|---|---|---|---|
| | *Feet.* | *Feet.* | *Feet.* | *Tons.* |
| Gasconade | 107 | 22 | 3.3 | 74. |
| Pin Oak | 95 | 17.5 | 2.2 | 43.05 |
| Royal | 86.6 | 24 | 3 | 44.82 |
| Jumbo (gasoline) | 57.5 | 16 | 2.75 | 25 |

## Y 5.

## IMPROVEMENT OF OSAGE RIVER, MISSOURI.

The project for improvement of this stream, adopted in 1871, has consisted in the removal of obstructions to navigation, as snags and leaning timber, and in deepening channels over shoals by means of dredging, and the construction of cross and wing dams to concentrate the water over the shoal places.

The original estimated cost of the project was $230,000, but after that project was adopted, the extent of river for which appropriations were made covered more ground than was originally considered, and for a number of years past no estimate of cost of the improvement by removal of snags, shoals, etc., appears to have been rendered in annual reports.

The first efforts at improvement after the General Government assumed charge in 1871 were expended in dredging on the shoals. After this the method pursued consisted in the construction of dams and training walls, and removal of snags, leaning timbers, etc.

The construction of a lock and dam near the mouth of the river was authorized by the river and harbor act of September 19, 1890. The estimated cost of the lock and dam as given in the last Annual Report is $200,000.

An improvement of a portion of the river was undertaken by the State of Missouri a number of years before the General Government assumed charge in 1871. This improvement consisted of a number of wing dams built out from the banks to concentrate the flow of water in a narrow channel with a view to securing an increase in depth through scour. These dams, however, were not kept in repair, and they did not secure the results desired.

Before improvement of the river was undertaken by the Government the channels were so obstructed by snags, trees, and shoals as to make navigation precarious at high stages of water and almost impossible in some portions of the river at low-water stage.

Every high stage of water carries more or less snags into the channel, besides causing scour of banks, resulting in obstructions which have to be removed.

The amount expended by the General Government upon the improvement to June 30, 1892, was $211,701.72. It resulted in benefiting navigation on the river from its mouth to Osceola, Mo., a distance of about 230 miles. The lower 60 miles of the river were the most benefited.

The work of the fiscal year ending June 30, 1893, commenced July 15 last, and was continued until December. It consisted in removal of snags and overhanging trees and in construction of 250 linear feet of dams at Hoskins Shoal. This work by hired labor put the river in good navigable condition from its mouth to Grand River.

Amount expended during the year, $3,871.78.

The details of the work are given in the report, herewith, of Mr. J. W. Beaman, assistant engineer.

The sum of $65,000 can be profitably expended during the fiscal year ending June 30, 1895. Of this, the sum of $10,000 is estimated for removing obstructions and building wing dams and training walls where necessary, and $55,000 in constructing lock, it not having been considered desirable to undertake the lock construction until $140,000 were available for it.

A table of commercial statistics, to which attention is respectfully invited, is hereto appended.

*Appropriations made by Congress for improving Osage River, Missouri.*

| | |
|---|---|
| By act of— | |
| March 3, 1871 | $25,000 |
| June 10, 1872 | 25,000 |
| March 3, 1873 | 25,000 |
| June 23, 1874 | 25,000 |
| June 18, 1878 | 20,000 |
| March 2, 1879 | 20,000 |
| June 14, 1880 | 30,000 |
| March 3, 1881 | 20,000 |
| August 5, 1886 | 10,000 |
| August 11, 1888 | 5,000 |
| September 19, 1890 | 55,000 |
| July 13, 1892 | 50,000 |
| Total | 310,000 |

*Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $48,298.28 |
| Amount appropriated by act approved July 13, 1892 | 50,000.00 |
| | 98,298.28 |
| June 30, 1893, amount expended during fiscal year | 3,871.78 |
| July 1, 1893, balance unexpended | 94,426.50 |
| July 1, 1893, outstanding liabilities | 327.67 |
| July 1, 1893, balance available | 94,098.83 |
| Amount (estimated) required for completion of existing project | 110,000.00 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895 | *65,000.00 |
| Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893. | |

### REPORT OF MR. J. W. BEAMAN, ASSISTANT ENGINEER.

JEFFERSON CITY, MO., *June 30, 1893.*

MAJOR: I have the honor to submit the following report upon the improvement of the Osage River, Missouri and Kansas, for the fiscal year ending June 30, 1893.

Improvement work on the Osage River during the past year has been confined to the removal of obstructions to steamboat and raft navigation and the closing of the two side chutes at the foot of Hoskins Shoal.

*Snagging, etc.*—In accordance with the instructions of your predecessor, Maj. A. M. Miller, U. S. Engineer, by letter of July 16, 1892, a party was organized for the removal of channel and bank obstructions to navigation.

The party as organized consisted of a foreman and 5 laborers, which number was subsequently increased to 10 men all told.

---

* $10,000 in removing obstructions; $55,000 in constructing lock.

The outfit provided consisted of a covered flatboat 25 feet by 12 feet by 20 inches, a flatboat 20 feet by 10 feet by 20 inches, two skiffs, an iron capstan, ropes, blocks, and all other tools necessary for snagging.

For towing the boats and working the capstan a mule was hired.

The party was organized at Teal, 34 miles above the mouth of the river.

After some repairs had been made to the covered flatboat and an examination had been made of the river below Teal, which developed the fact that at the date of the organization of the party there were neither trees nor overhanging trees obstructing navigation between Teal and the mouth, the plant was moved upstream, and the work of clearing the channel and banks of obstructions was commenced, and continued until December 6.

On this date, because of the lateness of the season, the party was disbanded, and the plant was left for the winter in charge of a watchman at Brenekes Shoal, to which point the plant had previously been brought from the upper river.

*Hoskins Shoal improvement.*—Between the dates October 1 and November 17 3 men were employed at the foot of Hoskins Shoal, 42 miles above the mouth of the river, in the closing of two side chutes, by which a large part of the available water had previously been deflected from the main channel.

The total combined length of these dams was 250 feet, with an average breadth of crest of 7½ feet and an average height above low water of 18 inches.

In this work there were used 165 small piles, 3 to 6 inches in diameter and up to 8 feet in length, and 108 cubic yards of riprap rock.

The following tabulated statement will indicate the work accomplished during the season.

### IMPROVEMENT WORK, OSAGE RIVER, JULY 16 TO DECEMBER 6, 1892.

*Snagging, etc.*

| | |
|---|---|
| Snags, etc., removed from the channel | 186 |
| Rocks removed from the channel | 5 |
| Drift trees cut into 16-foot lengths | 1,722 |
| Overhanging trees felled and cut up | 962 |
| Miles of river worked | 179 |

*Construction.*

| | |
|---|---|
| Linear feet of riprap dam built | 250 |
| Small piles, 3 by 8 inches diameter, used | 165 |
| Cubic yards of riprap rock used | 108 |

By the above snagging and construction work the river was put in good navigable condition from the mouth of Grand River to the point of union of the Osage and Missouri rivers at Osage City.

*Lock and dam at Brenekes Shoal.*—Incident to the construction of a lock and dam projected for the foot of Brenekes Shoal, guages have been maintained, and observations of the same have been made daily at 8 o'clock a. m. at Tuscumbia, Burds Shoal, Brenekes Shoal, and Osage City.

*Project for next year.*—This fall it is desirable that a party be organized to remove channel and bank obstructions from the head of steamboat navigation above Osceola to the Missouri River, to complete the work projected for the season of 1892, and to remove such obstructions from the lower river below the mouth of Grand River as may have accumulated since the 6th of last December.

The extent of river line included in the above project is upward of 245 miles.

No river improvement work has been done above the mouth of Grand River since 1882.

The upper portion of the river above Osceola, 230 miles above the mouth, is traversed by the *Black Diamond;* and the *Andrew Bennett*, a boat which was taken to Warsaw last fall, run between Warsaw and Osceola.

The commerce of the river below Warsaw is carried by the *Hugo, Frederick, Edna,* and *Annie Dell.*

For the work of the next two years, in addition to the balance needed for the construction of the projected lock and dam at Brenekes Shoal, $10,000 should be available for the removal of snags, etc., and for minor construction works at troublesome shoals.

I have the honor to be, very respectfully, your obedient servant,

J. W. Beaman,
*Assistant Engineer.*

Maj. Chas. J. Allen,
*Corps of Engineers, U. S. A.*

*Record of gauge at Tuscumbia, Mo., for fiscal year ending June 30, 1893.*

| Day. | July. | Aug. | Sept. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | April. | May. | June. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2.70 | 2.65 | .95 | .60 | 1.45 | 1.45 | 1.60 | .90 | 4.40 | 4.70 | 31.35 | 20.60 |
| 2 | 3.65 | 2.20 | .95 | .60 | 1.35 | 1.50 | 1.60 | 2.25 | 4.00 | 4.60 | 30.45 | 26.40 |
| 3 | 9.75 | 1.95 | .95 | .75 | 1.20 | 1.55 | 1.90 | 2.10 | 3.75 | 4.45 | 28.40 | 25.65 |
| 4 | 10.90 | 1.75 | .90 | .70 | 1.10 | 1.45 | 1.60 | 1.75 | 3.65 | 4.30 | 25.60 | 21.50 |
| 5 | 8.40 | 1.60 | 1.00 | .60 | 1.05 | 1.35 | 1.55 | 1.30 | 3.50 | 4.00 | 22.35 | 17.35 |
| 6 | 7.80 | 1.50 | .95 | .55 | .95 | 1.55 | 1.90 | 1.20 | 3.30 | 4.15 | 17.75 | 18.10 |
| 7 | 6.50 | 1.40 | .85 | .50 | .85 | 3.50 | 2.00 | 1.60 | 3.15 | 4.20 | 16.10 | 19.60 |
| 8 | 5.65 | 1.35 | .85 | .45 | .80 | 4.50 | 1.90 | 2.15 | 4.75 | 3.85 | 14.90 | 19.85 |
| 9 | 4.90 | 1.25 | .80 | .40 | .75 | 5.90 | 1.70 | 3.20 | 8.35 | 4.15 | 14.20 | 18.10 |
| 10 | 4.25 | 1.45 | .75 | .35 | .70 | 6.00 | 1.85 | 2.90 | 9.80 | 5.15 | 15.35 | 15.35 |
| 11 | 3.75 | 1.75 | 1.55 | .30 | .70 | 5.70 | 1.70 | 2.70 | 10.35 | 7.50 | 15.90 | 13.90 |
| 12 | 3.40 | 2.40 | 1.20 | .30 | .65 | 5.00 | 1.65 | 2.45 | 10.00 | 11.50 | 15.30 | 13.25 |
| 13 | 3.70 | 2.00 | 1.00 | .30 | .60 | 4.40 | 2.00 | 2.30 | 8.70 | 12.80 | 14.75 | 12.65 |
| 14 | 3.75 | 1.80 | .95 | .30 | .60 | 3.70 | 2.20 | 2.75 | 7.30 | 13.10 | 14.15 | 12.40 |
| 15 | 3.90 | 2.65 | 1.00 | .25 | .55 | 3.20 | 2.10 | 3.55 | 6.20 | 11.85 | 13.80 | 12.20 |
| 16 | 4.95 | 2.70 | 1.00 | .25 | .80 | 2.90 | 2.00 | 4.40 | 5.40 | 10.20 | 12.35 | 10.95 |
| 17 | 11.60 | 2.60 | 1.00 | .25 | .80 | 2.75 | 1.85 | 3.80 | 4.80 | 8.50 | 11.00 | 8.25 |
| 18 | 11.25 | 2.35 | 1.20 | .35 | .95 | 2.70 | 1.60 | 3.65 | 4.30 | 7.10 | 10.05 | 6.10 |
| 19 | 8.00 | 2.05 | 1.25 | .35 | .95 | 2.75 | 1.70 | 3.65 | 3.90 | 6.20 | 8.65 | 5.20 |
| 20 | 6.10 | 1.75 | 1.20 | .30 | .90 | 2.65 | 1.70 | 4.70 | 3.55 | 19.60 | 7.10 | 5.05 |
| 21 | 5.70 | 1.50 | 1.10 | .70 | 1.05 | 2.60 | 1.40 | 4.30 | 3.30 | 26.00 | 6.65 | 4.80 |
| 22 | 5.00 | 1.30 | 1.00 | 2.90 | 1.10 | 2.70 | 1.25 | 4.95 | 5.10 | 27.35 | 11.80 | 5.00 |
| 23 | 4.35 | 1.20 | .90 | 3.35 | 1.05 | 2.70 | 1.10 | 4.95 | 5.35 | 26.75 | 9.60 | 5.05 |
| 24 | 3.75 | 1.15 | .80 | 2.30 | 1.15 | 2.55 | 1.00 | 4.85 | 6.20 | 24.25 | 7.75 | 4.80 |
| 25 | 3.15 | 1.15 | .75 | 2.50 | 1.15 | 2.40 | .95 | 4.85 | 6.55 | 21.80 | 9.00 | 4.45 |
| 26 | 2.90 | 1.20 | .70 | 2.55 | 1.20 | 2.20 | 1.00 | 4.90 | 6.20 | 24.50 | 9.85 | 4.10 |
| 27 | 2.50 | 1.35 | .70 | 2.35 | 1.25 | 2.40 | 1.05 | 4.70 | 5.60 | 27.40 | 14.10 | 3.65 |
| 28 | 2.15 | 1.15 | .75 | 2.05 | 1.25 | 2.30 | .90 | 4.60 | 4.95 | 28.35 | 14.35 | 3.25 |
| 29 | 4.65 | 1.05 | .65 | 1.85 | 1.50 | 2.20 | .80 | ....... | 4.60 | 27.70 | 12.60 | 3.05 |
| 30 | 3.85 | 1.15 | .60 | 1.70 | 1.50 | 1.95 | .80 | ....... | 4.50 | 29.45 | 11.40 | 5.60 |
| 31 | 2.10 | 1.00 | ....... | 1.55 | ....... | 1.70 | .90 | ....... | 4.50 | ........ | 11.35 | ....... |

COMMERCIAL STATISTICS—OSAGE RIVER, MISSOURI AND KANSAS.

| Articles. | 1890. | 1891. | 1892. |
|---|---|---|---|
| | *Tons.* | *Tons.* | *Tons.* |
| Hay, grain, seeds, etc | 5,118 | 6,135 | 5,471 |
| Lumber, logs, wood, railway ties, etc | 86,349 | 77,195 | 69,721 |
| Live stock | 766 | 957 | 739 |
| Produce | 319 | 527 | 182 |
| Salt | 482 | 602 | 281 |
| Barytes | 1,710 | 2,775 | 1,200 |
| Iron, nails, etc | 408 | 510 | 67 |
| Farm machinery | 453 | 588 | 83 |
| General merchandise | 1,408 | 1,760 | 1,536 |
| Total | 97,013 | 91,049 | 79,290 |

*List of steam-power boats engaged in commerce on the Osage River during the year 1892.*

| Name. | Length. | Breadth. | Depth. | Gross tonnage. |
|---|---|---|---|---|
| | *Feet.* | *Feet.* | *Feet.* | *Tons.* |
| Annie Dell | 70. | 16. | 2. | 19.05 |
| Black Diamond | 72.5 | 14.4 | 2.3 | 18.4 |
| Edna | 102. | 21.5 | 4.7 | 83.35 |
| Frederick | 96.4 | 14.3 | 2. | 82.51 |
| John A. Hugo | 127. | 20. | 3. | 126.88 |

## Y 6.

## IMPROVEMENT OF KASKASKIA RIVER, ILLINOIS.

A survey of this stream from New Athens to its mouth was made in 1887.

The project for improvement, adopted in 1890, consists in deepening the water over the two principal shoals between the mouth of the river and Evansville, viz, at the Nine Mile and the Evansville shoals, and in removing snags and other obstructions from the mouth to the Baldwin bridge, a distance of about 22 miles. Estimated cost of the project, $10,500.

Before work for improvement was undertaken by the Government the stream was practically blocked near its mouth during the low-water season by the Nine Mile Shoal over which there was often a depth of only 9 inches when the St. Louis gauge read 6.5 feet. In addition, the navigation was greatly obstructed on account of snags, shoals, and bars.

At high water navigation was possible as far up the stream as New Athens.

The first appropriation for the improvement was $6,000, made by the river and harbor act of September 19, 1890.

During the fall and part of December, 1891, Nine Mile and Evansville shoals were excavated, the former so as to give a channel 75 feet wide and 36 inches deep, and the latter to give a channel 60 feet wide and 34 inches deep, at low water, the excavated material being utilized in constructing dikes, etc., to concentrate the flow of water in the cuts. A number of snags were also removed from the channel.

This work was of great benefit to the commerce of the river.

The river and harbor act of July 13, 1892, appropriated $4,500 for the improvement. Under this appropriation work was resumed in September, 1892, by hired labor, and prosecuted until December 23, when it was suspended on account of cold weather. The work of the season (1892) consisted in removal of snags, trees, rack heaps, logs, and several rocks from Baldwin bridge to Cox's Ferry, thus further improving the navigation.

The result of all the work done is that steamboats are enabled to navigate the stream at lower stages, and for low-water seasons of greater length, than formerly was the case.

| | |
|---|---|
| Expended upon the improvement to July 1, 1892 | $5,760.48 |
| Expended upon the same during the fiscal year ending June 30, 1893 | 3,347.63 |

It is proposed to expend the small balance remaining from the appropriation in care of the work and in further removal of obstructions so far as the funds will admit of.

*Appropriations made by Congress for improving Kaskaskia River, Illinois.*

| | |
|---|---|
| By act of September 19, 1890 | $6,000 |
| By act of July 13, 1892 | 4,500 |
| | 10,500 |

*Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $239.52 |
| Amount appropriated by act approved July 13, 1892 | 4,500.00 |
| | 4,739.52 |
| June 30, 1893, amount expended during fiscal year | 3,347.63 |
| July 1, 1893, balance unexpended | 1,391.89 |
| July 1, 1893, outstanding liabilities | 9.49 |
| July 1, 1893, balance available | 1,382.40 |

## COMMERCIAL STATISTICS, KASKASKIA RIVER, ILLINOIS.

[Compiled from information furnished by Mr. Nick Sauer, of Evansville, Ill., and Capt. Harvey Neville, of Chester, Ill.]

| Articles. | 1890. | 1891. | 1892. |
|---|---|---|---|
| | *Tons.* | *Tons.* | *Tons.* |
| Coal | 60 | 400 | 300 |
| Cordwood and lumber | 2,105 | 2,054 | 3,000 |
| Flour, grain, etc | 5,837 | 9,186 | 600 |
| Merchandise | 400 | 405 | 500 |
| Total | 8,402 | 12,045 | 4,400 |

*List of steam-power boats engaged in commerce on the Kaskaskia River, Illinois.*

| Name. | Length. | Breadth. | Depth. | Gross tonnage. |
|---|---|---|---|---|
| | *Feet.* | *Feet.* | *Feet.* | *Tons.* |
| Dolphin | 135.8 | 22.8 | 4.8 | 156.16 |
| Little Nick | 60.0 | 10.0 | 3.0 | 14.22 |
| Mary M. Michael | 143.3 | 26.3 | 4.4 | 234.44 |
| Nick Sauer | 100.0 | 18.0 | 4.0 | 99.27 |

# APPENDIX Z.

## IMPROVEMENT OF MISSISSIPPI RIVER BETWEEN MOUTH OF MISSOURI RIVER AND MINNEAPOLIS.

### *REPORT OF MAJ. ALEXANDER MACKENZIE, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1893, WITH OTHER DOCUMENTS RELATING TO THE WORKS.*

#### IMPROVEMENTS.

1. Operating snag boats and dredge boats on upper Mississippi River.
2. Mississippi River between Missouri River and Minneapolis.
3. Des Moines Rapids, Mississippi River.
4. Operating and care of Des Moines Rapids Canal and Dry Dock.

#### EXAMINATIONS.

5. Hamburg Bay, on Mississippi River, Calhoun County, Ill.
6. Mississippi River, Iowa side, from mouth of Iowa River to Burlington.
7. Moline Harbor, Ill.
8. Mississippi River at and near Bellevue, Iowa.
9. Additional harbors of refuge on Lake Pepin, Mississippi River.

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UNITED STATES ENGINEER OFFICE,
*Rock Island, Ill., July 6, 1893.*

GENERAL: I have the honor to transmit herewith the annual reports upon the works in my charge during the fiscal year ending June 30, 1893.

Very respectfully, your obedient servant,

A. MACKENZIE,
*Major, Corps of Engineers.*

Brig. Gen. THOMAS L. CASEY,
*Chief of Engineers, U. S. A.*

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## Z 1.

## OPERATING SNAG BOATS AND DREDGE BOATS ON UPPER MISSISSIPPI RIVER.

The work covered by this appropriation is the removal of snags, wrecks, and other obstructions, the cutting and pulling back of overhanging trees, the clearing of shores, the searching for and marking of new channels, assisting stranded boats and barges, surveys and examinations in connection with new improvements and for facilitating navigation through bridges, inspection and repair of works, formation of temporary or permanent channels through obstructing bars, and, in general, in benefiting commerce by aiding existing navigation and assisting in the permanent improvement of the Upper Mississippi River.

The plant belonging to this work consists of the snag boats *General Barnard* and *J. G. Parke*, and to these are added, as occasion demands and circumstances permit, dredges, launches, barges, etc., belonging to the general appropriations. The operations of the snag boats and dredges extend from Minneapolis to the mouth of the Missouri River, about 724 miles. At times when the snag boats are not required on work above mentioned they are used under general or special appropriations for work of permanent construction.

By the river and harbor act of August 11, 1888, provision was made for operating snag boats and dredge boats on the Upper Mississippi River under a permanent appropriation, the annual expenditure being limited by the act to $25,000. There has been expended under the permanent appropriation during the fiscal year ending June 30, 1893, the sum of $25,000.

The snag boat *General Barnard* was engaged in the work of removing snags, etc., July 14 to November 6, 1892, April 10 to May 2, and May 21 to June 30, 1893.

The snag boat *J. G. Parke* and dredge *Phoenix* were employed as a dredging and wrecking plant August 10 to September 10, and October 26 to November 5, 1892.

The details of work accomplished, together with statistics of commerce and navigation, are given in the appended report of Assistant Engineer C. W. Durham.

A detailed statement and a summary of expenditures for operating snag boats and dredge boats on Upper Mississippi River for the fiscal year ending June 30, 1893, are appended.

The total tonnage of the Mississippi River, between the Falls of St. Anthony and mouth of Missouri River, for calendar year 1892, was approximately 4,500,000 tons. This includes logs and lumber as well as ordinary merchandise.

*Abstract of appropriations.*

| | |
|---|---|
| By act approved March 2, 1867 | $96,000 |
| By allotment from appropriation of July 25, 1868 | 26,000 |
| By allotment from appropriation of 1869 | 35,640 |
| By act approved— | |
| July 11, 1870 | 36,000 |
| March 3, 1871 | 42,000 |
| June 10, 1872 | 42,000 |
| March 3, 1873 | 25,000 |
| June 23, 1874 | 25,000 |
| March 3, 1875 | 25,000 |
| August 14, 1876 | 30,000 |
| June 18, 1878 | 41,500 |
| March 3, 1879 | 20,000 |
| June 14, 1880 | 8,000 |
| March 3, 1881 | 25,000 |
| By act passed August 2, 1882 | 25,000 |
| By act approved August 5, 1886 | 22,500 |
| By act of August 11, 1888, for fiscal years ending— | |
| June 30, 1889 | 25,000 |
| June 30, 1890 | 25,000 |
| June 30, 1891 | 25,000 |
| June 30, 1892 | 25,000 |
| June 30, 1893 | 25,000 |
| Total | 649,640 |

## *Money statement.*

| | |
|---|---|
| June 30, 1893, amount drawn from Treasury under permanent appropriation | $25,000.00 |
| June 30, 1893, amount expended during fiscal year | 25,000.00 |
| July 1, 1893, amount available, under permanent appropriation of August 11, 1888, for fiscal year ending June 30, 1894 | 25,000.00 |

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### *Detailed statement of expenditures for operating snag boats and dredge boats on Upper Mississippi River for the fiscal year ending June 30, 1893.*

| Number of voucher. | To whom paid. | Total. | Office expenses, superintendence and contingencies. | Labor. | Subsistence. | Fuel. | Expense. | Repairs. |
|---|---|---|---|---|---|---|---|---|
| | *July, 1892.* | | | | | | | |
| 1 | Simmons Hardware Co | $48.00 | | | | | $48.00 | |
| 2 | Wilkinson & Co | 21.75 | | | | | 21.75 | |
| 3 | C. W. Durham | 2.00 | $2.00 | | | | | |
| 4 | J. C. McElhern | 4.53 | 4.53 | | | | | |
| 5 | E. E. Barrett | 6.23 | 6.23 | | | | | |
| 6 | McElroy Iron Works Co | 28.53 | | | | | | $28.53 |
| 7 | T. Nodler | 36.87 | | | $36.37 | | .50 | |
| 8 | Frank J. Weess | 34.74 | | | 34.74 | | | |
| 9 | Menasha Wood Split Pulley Co | 39.71 | | | | | | 39.71 |
| 10 | J. H. Scrogum | 6.20 | | | 6.20 | | | |
| 11 | Klindt, Geiger & Co | 12.00 | | | 12.00 | | | |
| 12 | C. P. Comegys | 7.29 | 7.29 | | | | | |
| 13 | C. J. Long | 22.89 | | | 22.64 | | .25 | |
| 14 | Thomas E. Schindler & Co | 25.02 | | | 25.02 | | | |
| 15 | J. W. Stewart | 1.45 | | | | | 1.45 | |
| 16 | Coal Valley Mining Co | 9.00 | | | | $9.00 | | |
| 17 | J. and M. Fugina | 15.13 | | | | 15.13 | | |
| 18 | C. P. Disney & Son | 127.80 | | | | 127.80 | | |
| 19 | The E. M. Dickey Co | 42.77 | | | | 42.77 | | |
| 20 | T. C. Bright | 34.50 | | | | 34.50 | | |
| 21 | Hired men | 340.00 | | $340.00 | | | | |
| 22 | ......do | 1,583.00 | 250.00 | 1,333.00 | | | | |
| 23 | Kranz Bros | 22.23 | | | 22.23 | | | |
| 24 | Yanz & Sons | 7.65 | | | 7.65 | | | |
| | Total | 2,479.29 | 270.05 | 1,673.00 | 166.85 | 229.20 | 71.95 | 68.24 |
| | *August, 1892.* | | | | | | | |
| 1 | Hired men | 39.80 | | | | | | 39.80 |
| 2 | McElroy Iron Works Co | 11.59 | | | | | | 11.59 |
| 3 | George Lamont | 81.00 | | | | 81.00 | | |
| 4 | Thomas E. Schindler & Co | 22.86 | | | 22.86 | | | |
| 5 | Charles J. Long | 9.93 | | | 8.63 | | 1.30 | |
| 6 | J. H. Scrogum | 4.85 | | | 4.85 | | | |
| 7 | Gaunitz, Bros. & Schwab | 41.84 | | | 19.14 | 20.00 | 2.70 | |
| 8 | The E. M. Dickey Co | 36.00 | | | | 36.00 | | |
| 9 | Quincy Coal Co | 11.16 | | | | 11.16 | | |
| 10 | James Ward & Son | 71.72 | | | | | 71.72 | |
| 11 | Page & Tolkacs | 13.15 | | | | | 13.15 | |
| 12 | Western Coal and Tow Co | 105.00 | | | | 105.00 | | |
| 13 | .....do | 5.00 | | | | | 5.00 | |
| 14 | A. Boschert & Co | 52.16 | | | 52.16 | | | |
| 15 | Henry A. Koettker | 22.65 | | | 22.65 | | | |
| 16 | The W A. Bonsack Lumber Co | 74.16 | | | | | | 74.16 |
| 17 | C. W. Durham | 13.10 | 13.10 | | | | | |
| 18 | Quincy Coal Co | 18.00 | | | | 18.00 | | |
| 19 | L. T. Biethan | 23.75 | | | | 23.75 | | |
| 20 | Jacob Auer | 20.00 | | | | 20.00 | | |
| 21 | T. Nodler | 17.74 | | | 17.74 | | | |
| 22 | Frank J. Weess | 17.37 | | | 17.37 | | | |
| 23 | Mississippi Coal and Ice Co | 30.22 | | | 12.22 | 18.00 | | |
| 24 | McElroy Iron Works Co | 16.58 | | | | | | 16.58 |
| 25 | King & Frick | 36.00 | | | | 36.00 | | |
| 26 | H. O. Browning | 36.00 | | | | 36.00 | | |
| 27 | Smith Brothers | 170.40 | | | 160.90 | | 9.50 | |
| 28 | A. Weber Co | 8.24 | | | | | 8.24 | |
| 29 | Seither & Cherry Co | 1.45 | | | | | 1.45 | |

*Detailed statement of expenditures for operating snag boats and dredge boats on Upper Mississippi River for the fiscal year ending June 30, 1893*—Continued.

| Number of voucher. | To whom paid. | Total. | Office expenses, superintendence and contingencies. | Labor. | Subsistence. | Fuel. | Expense. | Repairs. |
|---|---|---|---|---|---|---|---|---|
| | *August, 1892*—Continued. | | | | | | | |
| 30 | McDermott & Sons | $100.69 | | | | $100.69 | | |
| 31 | Wilkinson & Co | 12.13 | | | | | $12.13 | |
| 32 | Hired men | 838.02 | | $838.02 | | | | |
| 33 | ......do | 1,369.16 | | 1,369.16 | | | | |
| | Total | 3,331.22 | $13.10 | 2,207.18 | $338.52 | 505.60 | 125.19 | $141.63 |
| | *September, 1892.* | | | | | | | |
| 1 | Coal Valley Mining Co | 36.00 | | | | 36.00 | | |
| 2 | King & Frick | 63.33 | | | 18.33 | 45.00 | | |
| 3 | Charles J. Long | 29.79 | | | 29.04 | | 0.75 | |
| 4 | George Lamont | 45.00 | | | | 45.00 | | |
| 5 | Thomas E. Schindler & Co | 39.74 | | | 39.74 | | | |
| 6 | A. Boschert & Co | 5.40 | | | 5.40 | | | |
| 7 | John Whitfield | 21.02 | | | 21.02 | | | |
| 8 | Eastman & Brinton | 8.10 | | | 8.10 | | | |
| 9 | R. W. Stanton & Co | 41.59 | | | 40.04 | | 1.55 | |
| 10 | D. C. Slaten | 13.90 | | | 13.90 | | | |
| 11 | George F. Kirsch | 37.49 | | | 37.49 | | | |
| 12 | Western Coal and Tow Co | 63.00 | | | | 63.00 | | |
| 13 | Quincy Coal Co | 28.80 | | | | 28.80 | | |
| 14 | St. Louis Tent and Awning Co | 6.50 | | | | | 6.50 | |
| 15 | C. W. Durham | 8.25 | 8.25 | | | | | |
| 16 | Gaunitz Bros. & Schwab | 49.54 | | | 9.54 | 40.00 | | |
| 17 | The E. M. Dickey Co | 36.00 | | | | 36.00 | | |
| 18 | S. G. Garnett | 63.25 | | | | 63.25 | | |
| 19 | J. H. Scrogum | 43.37 | | | 43.37 | | | |
| 20 | Dennis Noonan | 80.00 | | | | 80.00 | | |
| 21 | T. Nodler | 100.98 | | | 99.78 | | 1.20 | |
| 22 | Henry Melvan | 13.09 | | | 13.09 | | | |
| 23 | Conrad Bros | 38.71 | | | 38.71 | | | |
| 24 | Standard Oil Co | 17.98 | | | | | 17.98 | |
| 25 | McElroy Iron Works Co | 10.70 | | | | | 10.70 | |
| 26 | C. W. Disney | 90.00 | | | | 90.00 | | |
| 27 | R. Crampton & Co | 6.50 | 6.50 | | | | | |
| 28 | C. W. Durham | 4.50 | 4.50 | | | | | |
| 29 | John Harry | 69.00 | | | | 69.00 | | |
| 30 | Jacob Richtman | 40.00 | | | | 40.00 | | |
| 31 | John Furlong | 9.00 | | | 9.00 | | | |
| 32 | Yans Bros | 5.25 | | | 5.25 | | | |
| 33 | Krans Bros | 28.65 | | | 28.65 | | | |
| 34 | St. Louis Steam Forge and Iron Works | 45.13 | | | | | | 45.13 |
| 35 | Sundry persons | 40.55 | | | 20.55 | 20.00 | | |
| 36 | F. H. Ketcham | 95.40 | | | | 95.40 | | |
| 37 | McElroy Iron Works Co | 35.53 | | | | | | 35.53 |
| 38 | Gaunitz Bros. & Schwab | 37.50 | | | 7.50 | 30.00 | | |
| 39 | Klindt, Geiger & Co | 17.60 | | | 17.60 | | | |
| 40 | J. H. Scrogum | 10.25 | | | 10.25 | | | |
| 41 | The Pilot Steamboat Co | 22.50 | | | | 22.50 | | |
| 42 | T. E. Schindler & Co | 37.11 | | | 37.11 | | | |
| 43 | Chas. J. Long | 3.00 | | | 2.30 | | .70 | |
| 44 | Coal Valley Mining Co | 45.00 | | | | 45.00 | | |
| 45 | The E. M. Dickey Co | 27.00 | | | | 27.00 | | |
| 46 | L. T. Biethan | 33.25 | | | | 33.25 | | |
| 47 | Western Coal and Tow Co | 105.00 | | | | 105.00 | | |
| 48 | James Ward & Son | 40.91 | | | 24.23 | 16.68 | | |
| 49 | Henry A. Koettker | 14.75 | | | 14.75 | | | |
| 50 | A. Boschert & Co | 41.36 | | | 41.36 | | | |
| | Total | 1,806.27 | 19.25 | | 636.10 | 1,030.88 | 39.38 | 80.66 |
| | *October, 1892.* | | | | | | | |
| 1 | Hired men | 230.68 | | 230.68 | | | | |
| 2 | ......do | 1,374.67 | | 1,374.67 | | | | |
| 3 | Geo. West | 20.00 | | 20.00 | | | | |
| 4 | Hired men | 359.66 | | 359.66 | | | | |
| 5 | ......do | 339.00 | | 339.00 | | | | |
| 6 | C. W. Durham | 4.50 | 4.50 | | | | | |
| 7 | H. Q. Browning | 27.00 | | | | 27.00 | | |
| 8 | L. T. Biethan | 38.00 | | | | 38.00 | | |

*Detailed statement of expenditures for operating snag boats and dredge boats on Upper Mississippi River for the fiscal year ending June 30, 1893*—Continued.

| Number of voucher. | To whom paid. | Total. | Office expenses, superintendence and contingencies. | Labor. | Subsistence. | Fuel. | Expense. | Repairs. |
|---|---|---|---|---|---|---|---|---|
| | *October, 1892*—Continued. | | | | | | | |
| 9 | Quincy Coal Co | $18.00 | | | | $18.00 | | |
| 10 | T. S. Adams | 4.30 | | | $4.30 | | | |
| 11 | Standard Oil Co | 7.24 | | | | | $7.24 | |
| 12 | Mississippi Coal and Ice Co | 13.96 | | | 13.96 | | | |
| 13 | Frank J. Weess | 7.02 | | | 7.02 | | | |
| 14 | T. Nodler | 3.87 | | | 3.87 | | | |
| 15 | King & Frick | 36.00 | | | | 36.00 | | |
| 16 | James McNamara | 61.50 | | | | 61.50 | | |
| 17 | L. T. Biethan | 36.00 | | | | 36.00 | | |
| 18 | Werneth & Gehring | 1.04 | | | 1.04 | | | |
| 19 | Colburn & Baker | 9.50 | | | 9.50 | | | |
| 20 | James Leach | 8.00 | | | 8.00 | | | |
| 21 | H. C. Hodge & Sons | 20.24 | | | 20.24 | | | |
| 22 | R. H. Coons | 5.84 | | | 5.84 | | | |
| 23 | J. C. Stewart | 3.10 | | | 3.10 | | | |
| 24 | A. J. Stillwell Meat Co | 3.60 | | | 3.60 | | | |
| 25 | The Van Duzen & Tift Co | 7.46 | | | | | 7.46 | |
| 26 | McElroy Iron Works Co | 13.33 | | | | | | $13.33 |
| 27 | Klindt, Geiger & Co | 19.13 | | | 19.13 | | | |
| 28 | W. H. Pape | 44.00 | | | | 44.00 | | |
| 29 | Sundry persons | 42.30 | | | 27.30 | 15.00 | | |
| 30 | C. W. Durham | 9.05 | $9.05 | | | | | |
| 31 | Wabash Coal Co | 94.01 | | | | 94.01 | | |
| 32 | T. C. Bright | 36.80 | | | | 36.80 | | |
| 33 | S. G. Garnett | 64.40 | | | | 64.40 | | |
| 34 | The E. M. Dickey Co | 54.78 | | | | 54.78 | | |
| 35 | John Harry | 77.70 | | | | 77.70 | | |
| 36 | W. H. Pape | 27.50 | | | | 27.50 | | |
| 37 | Jacob Richtman | 50.00 | | | | 50.00 | | |
| 38 | John Furlong | 3.00 | | | 3.00 | | | |
| 39 | R. T. Wilson | 9.75 | | | 9.75 | | | |
| 40 | J. H. Scrogum | 14.00 | | | 14.00 | | | |
| 41 | Gannits Bros. & Schwab | 16.26 | | | 13.86 | | 2.40 | |
| 42 | Gentzkow Bros | 7.05 | | | 7.05 | | | |
| 43 | F. W. Luley & Son | 38.85 | | | 38.85 | | | |
| | Total | 3,262.09 | 13.55 | 2,324.01 | 213.41 | 680.69 | 17.10 | 13.33 |
| | *November, 1892.* | | | | | | | |
| 1 | Hired men | 1,311.00 | | 1,311.00 | | | | |
| 2 | C. W. Durham | 4.75 | 4.75 | | | | | |
| 3 | Anton Brink | 12.50 | | | | 12.50 | | |
| 4 | C. W. Durham | 5.80 | 5.80 | | | | | |
| 5 | Mississippi Coal and Ice Co | 18.00 | | | | 18.00 | | |
| 6 | Quincy Coal Co | 36.00 | | | | 36.00 | | |
| 7 | Western Coal and Tow Co | 105.00 | | | | 105.00 | | |
| 8 | The E. M. Dickey Co | 18.00 | | | | 18.00 | | |
| 9 | Geo. Lamont | 32.40 | | | | 32.40 | | |
| 10 | Coal Valley Mining Co | 90.00 | | | | 90.00 | | |
| 11 | Chas. J. Long | 65.72 | | | 62.37 | | 3.35 | |
| 12 | T. E. Schindler & Co | 80.08 | | | 80.08 | | | |
| 13 | A. Boschert & Co | 26.24 | | | 26.24 | | | |
| 14 | Henry A. Koettker | 7.00 | | | 7.00 | | | |
| 15 | James Ward & Son | 12.71 | | | 12.71 | | | |
| 16 | The W. A. Bonsack L. Co | 300.39 | | | | | | 300.39 |
| 17 | P. R. Sutton | 2.25 | | | | | 2.25 | |
| 18 | Vollers & Warttman | 18.35 | | | | | | 18.35 |
| 19 | St. Louis, Keokuk & North Western Ry | 46.66 | | | | | 46.66 | |
| 20 | Hired men | 337.67 | | 337.67 | | | | |
| 21 | Simmons Hardware Co | 57.90 | | | | | 57.90 | |
| 22 | Hired men | 191.50 | | 191.50 | | | | |
| | Total | 2,779.92 | 10.55 | 1,840.17 | 188.40 | 311.90 | 110.16 | 318.74 |
| | *December, 1892.* | | | | | | | |
| 1 | Hired men | 105.33 | | | | | | 105.33 |
| 2 | do | 445.00 | | 380.00 | | | | 65.00 |
| | Total | 550.33 | | 380.00 | | | | 170.33 |

*Detailed statement of expenditures for operating snag boats and dredge boats on Upper Mississippi River for the fiscal year ending June 30, 1893*—Continued.

| Number of voucher. | To whom paid. | Total. | Office expenses, superintendence and contingencies. | Labor. | Subsistence. | Fuel. | Expense. | Repairs. |
|---|---|---|---|---|---|---|---|---|
| | *January, 1893.* | | | | | | | |
| 1 | E. Schultz | $7.13 | | | | | $7.13 | |
| 2 | Hired men | 510.00 | | $380.00 | D. & T. | | | $130.00 |
| 3 | W. R. Johnson | 6.53 | | | | | | 6.53 |
| 4 | Wm. Barrett | 4.16 | | | | | | 4.16 |
| | Total | 527.82 | | 380.00 | | | 7.13 | 140.69 |
| | *February, 1893.* | | | | | | | |
| | (No vouchers). | | | | | | | |
| | *March, 1893.* | | | | | | | |
| 1 | Hired men | 510.00 | | 380.00 | | | | 130.00 |
| 2 | ......do | 13.19 | | | | | | 13.19 |
| 3 | C. W. Durham | 11.10 | $11.10 | | | | | |
| 4 | New Jersey Steel and Iron Co. | 46.52 | | | | | 46.52 | |
| 5 | A. Weber & Co | 2.89 | | | | | 2.89 | |
| 6 | C. W. Durham | 15.48 | 15.48 | | | | | |
| 7 | D. Tipton | 14.25 | 14.25 | | | | | |
| 8 | W. R. Tibbals | 4.50 | 4.50 | | | | | |
| 9 | Hired men | 543.00 | | 380.00 | D. & T. | | | 163.00 |
| 10 | Ewald Iron Co | 33.40 | | | | | | 33.40 |
| 11 | Carson & Rand | 61.29 | | | | | | 61.29 |
| 12 | A. Weber & Co | 6.20 | | | | | | 6.20 |
| | Total | 1,261.82 | 45.33 | 760.00 | | | 49.41 | 407.08 |
| | *April, 1893.* | | | | | | | |
| 1 | C. W. Durham | 12.05 | 12.05 | | | | | |
| 2 | Hired men | 18.50 | | | | | | 18.50 |
| 3 | C. W. Durham | 13.80 | 13.80 | | | | | |
| 4 | D. Tipton | 7.45 | 7.45 | | | | | |
| 5 | Irwin, Phillips & Co | 67.50 | | | | | 67.50 | |
| 6 | Brinkman & Co | 61.31 | | | | | 61.31 | |
| 7 | St. Louis, Keokuk and N. W. R. R. Co | 35.00 | | | | | 35.00 | |
| 8 | Standard Oil Co | 50.12 | | | | | 50.12 | |
| 9 | T. Nodler | 30.15 | | | $25.40 | | 4.75 | |
| 10 | Wilkinson & Co | 26.86 | | | | | 6.46 | 20.40 |
| 11 | King & Frick | 72.00 | | | | $72.00 | | |
| 12 | J. B. Eddington | 18.90 | | | 18.90 | | | |
| 13 | Ellett Brothers | 5.05 | | | 4.80 | | 0.25 | |
| 14 | Mississippi Coal and Ice Co | 169.63 | | | 7.78 | 61.20 | | 100.65 |
| 15 | Schulz Linquist Fur Co | 36.00 | | | | | 36.00 | |
| 16 | Frank J. Weess | 19.90 | | | 19.90 | | | |
| 17 | Vollers & Warttman | 1.68 | | | | | | 1.68 |
| 18 | Samuel E. Carey & Co | 27.30 | | | | | 27.30 | |
| 19 | Ben Wilson & Son | 1.10 | | | | | | 1.10 |
| 20 | Charles J. Long | 40.61 | 3.45 | | 35.61 | | 1.55 | |
| 21 | R. S. Blakemore | 4.20 | 4.20 | | | | | |
| 22 | Kellogg-Birge Co | 215.84 | | | 200.49 | | 15.35 | |
| 23 | T. E. Schindler | 28.62 | | | 28.62 | | | |
| 24 | Kellogg Birge Co | 213.02 | | | 189.91 | | 23.11 | |
| 25 | T. Nodler | 29.35 | | | 26.05 | | 3.30 | |
| 26 | C. J. Kuebler | 19.04 | | | 19.04 | | | |
| 27 | McElroy Iron Works Co | 33.59 | | | | | | 33.59 |
| 38 | Standard Oil Co | 17.70 | | | | | 17.70 | |
| 29 | A. Weber & Co | 27.93 | | | | | | 27.93 |
| 30 | Mississippi Coal and Ice Co | 35.00 | | | | | | 35.00 |
| 31 | William Andrus | 15.75 | | | | | | 15.75 |
| 32 | James McNamara | 68.25 | | | | 68.25 | | |
| 33 | Davis Company | 18.86 | | | | | 18.86 | |
| 34 | J. W. Stewart | 25.00 | | | | | 25.00 | |
| 35 | The Pilot Steamboat Co | 124.84 | | | | 124.84 | | |
| 36 | R. S. Blakemore | 13.36 | 13.36 | | | | | |
| 37 | James Ward & Son | 93.17 | | | 1.60 | | 91.57 | |
| 38 | A. Boschert & Co | 29.52 | | | 29.52 | | | |
| 39 | Henry A. Koettker | 13.50 | | | 13.50 | | | |
| 40 | John M. Keiflein | 126.00 | | | | 126.00 | | |
| 41 | G. C. Colbert | 10.00 | | | | 10.00 | | |
| 42 | Page & Tolkaiz | 28.85 | | | | | 28.85 | |
| 43 | George Hill | 150.27 | | | | | | 150.27 |
| 44 | George Hill | 298.27 | | | | | | 298.27 |

*Detailed statement of expenditures for operating snag boats and dredge boats on Upper Mississippi River for the fiscal year ending June 30, 1893*—Continued.

| Number of voucher. | To whom paid. | Total. | Office expenses, superintendence and contingencies. | Labor. | Subsistence. | Fuel. | Expense. | Repairs. |
|---|---|---|---|---|---|---|---|---|
| | *April, 1893*—Continued. | | | | | | | |
| 45 | Hired men | $1,318.83 | $100.00 | $1,218.83 | | | | |
| 46 | C. W. Durham | 4.00 | 4.00 | | | | | |
| 47 | Hired men | 607.67 | | 607.67 | | | | |
| | Total | 4,285.34 | 158.31 | 1,826.50 | $621.12 | $462.29 | $513.98 | $703.14 |
| | *May, 1893.* | | | | | | | |
| 1 | Hired men | 17.75 | | | | | | 17.75 |
| 2 | A. Mackenzie, Major of Engineers | 39.36 | 39.36 | | | | | |
| 3 | J. Ramser & Son | 1.50 | | | | | 1.50 | |
| 4 | Kahlke & Bro | 11.45 | | | | | | 11.45 |
| 5 | C. J. Long | 15.10 | | | 13.00 | | 2.10 | |
| 6 | Thos. E. Schindler & Co | 10.88 | | | 10.88 | | | |
| 7 | Coal Valley Mining Co | 9.00 | | | | 9.00 | | |
| 8 | R. S. Blakemore | 12.86 | 12.86 | | | | | |
| 9 | James Ward & Son | 29.90 | | | | | 29.90 | |
| 10 | T. Nodler | 17.25 | | | 9.40 | | 7.85 | |
| 11 | Wilkinson & Co | 26.00 | | | | | | 26.00 |
| 12 | Vellers & Warttman | 3.45 | | | | | | 3.45 |
| 13 | J. A. Fay & Egan Co | 16.30 | | | | | | 16.30 |
| 14 | Frank J. Weess | 21.82 | | | 21.82 | | | |
| 15 | J. W. Stewart | 5.28 | | | | | 5.28 | |
| 16 | Egbert, Fidlar & Chamber | 11.75 | 11.75 | | | | | |
| 17 | C. W. Durham | 8.75 | 8.75 | | | | | |
| 18 | Henry Balluff | 9.36 | 9.36 | | | | | |
| 19 | Henry A. Koettker | 9.05 | | | 9.05 | | | |
| 20 | The W. A. Bonsack Lumber Co. | 45.36 | | | | | | 45.36 |
| 21 | James Ward & Son | 4.00 | | | 2.25 | | 1.75 | |
| 22 | A. Boschert & Co | 73.48 | | | 73.48 | | | |
| 23 | Hired men | 468.33 | 468.33 | | | | | |
| | Total | 867.98 | 550.41 | | 139.88 | 9.00 | 48.38 | 120.31 |
| | *June, 1893.* | | | | | | | |
| 1 | Hired men | 462.65 | 16.67 | 445.98 | | | | |
| 2 | ......do | 500.00 | | 500.00 | | | | |
| 3 | C. W. & V. Coal Co | 57.50 | | | | 57.50 | | |
| 4 | Diamond Jo Line Steamers | 45.00 | | | | 45.00 | | |
| 5 | J. J. Hogan | 121.97 | | | 120.47 | | 1.50 | |
| 6 | The Consolidated Coal Co | 107.25 | | | | 107.25 | | |
| 7 | Coal Valley Mining Co | 122.61 | | | | 122.61 | | |
| 8 | J. H. Scrogum | 9.85 | | | 9.85 | | | |
| 9 | Ben Wilson & Son | 7.38 | | | | | | 7.38 |
| 10 | Thos. E. Schindler & Co | 45.59 | | | 45.59 | | | |
| 11 | Chas. J. Long | 16.20 | | | 15.95 | | .25 | |
| 12 | J. Siegrist | 6.25 | | | 6.25 | | | |
| 13 | C. W. Durham | 4.75 | 4.75 | | | | | |
| 14 | Gentzkon Bros | 28.33 | | | 28.33 | | | |
| 15 | Jacob Kieffer | 21.90 | | | 21.90 | | | |
| 16 | Fred Marx | 24.78 | | | 24.78 | | | |
| 17 | Harry & Richtman | 23.00 | | | | 23.00 | | |
| 18 | Uttley & White | 22.58 | | | 22.33 | | .25 | |
| 19 | Ben Wilson & Son | 21.44 | | | | | 21.44 | |
| 20 | Quick & Orum | 17.90 | | | | | 17.90 | |
| 21 | William Clendenin | 12.55 | | | | | | 12.55 |
| 22 | Diamond Jo Line Steamers | 27.00 | | | | 27.00 | | |
| 23 | Various persons | 29.40 | | | 3.90 | 25.50 | | |
| 24 | Chas. J. Long | 9.10 | | | 6.45 | | 2.65 | |
| 25 | Thos. E. Schindler & Co | 40.49 | | | 40.49 | | | |
| 26 | J. Siegrist | 5.00 | | | 5.00 | | | |
| 27 | Coal Valley Mining Co | 45.90 | | | | 45.90 | | |
| 28 | T. C. Bright | 23.00 | | | | 23.00 | | |
| 29 | L. F. Bakers' Sons | 28.29 | | | 28.29 | | | |
| 30 | T. E. Schindler & Co | 16.15 | | | 16.15 | | | |
| 31 | Chas. J. Long | 3.61 | | | 3.61 | | | |
| 32 | Hired men | 1,303.00 | 50.00 | 1,253.00 | | | | |
| 33 | ......do | 350.00 | | 350.00 | | | | |
| 34 | ......do | 287.50 | 287.50 | | | | | |
| | Total | 3,847.92 | 358.92 | 2,548.98 | 399.34 | 476.76 | 43.99 | 19.93 |

*Summary of expenditures for operating snag boats and dredge boats on Upper Mississippi River, for fiscal year ending June 30, 1893.*

| Months. | Office expenses, superintendence and contingencies. | Care, repair, and operating snag boats. | | | | | |
|---|---|---|---|---|---|---|---|
| | | Labor. | Subsistence. | Fuel. | Expense. | Repairs. | Total. |
| 1892. | | | | | | | |
| July | $270.05 | $1,333.00 | $166.85 | $229.20 | $50.20 | $68.24 | $1,847.49 |
| August | 13.10 | 1,369.16 | 177.62 | 384.91 | 93.87 | 110.69 | 2,136.25 |
| September | 19.25 | | 358.57 | 763.68 | 1.45 | 35.53 | 1,159.23 |
| October | 13.55 | 1,394.67 | 162.09 | 489.18 | 9.64 | 13.33 | 2,068.91 |
| November | 10.55 | 1,840.17 | 188.40 | 311.90 | 50.01 | 287.12 | 2,677.60 |
| December | | 380.00 | | | | 93.04 | 473.04 |
| 1893. | | | | | | | |
| January | | | | | 3.13 | 140.69 | 143.82 |
| February | | | | | | | |
| March | 45.33 | 380.00 | | | 49.41 | 65.00 | 494.41 |
| April | 158.31 | 1,218.83 | 386.12 | 269.20 | 426.01 | 422.10 | 2,722.26 |
| May | 550.41 | | 116.00 | | 39.50 | 105.93 | 261.43 |
| June | 358.92 | 1,698.98 | 398.84 | 476.76 | 4.65 | 7.88 | 2,587.11 |
| Total fiscal year | 1,439.47 | 9,614.81 | 1,954.49 | 2,924.83 | 727.87 | 1,349.55 | 16,571.55 |

| Months. | Care, repair, and operating dredge and tender. | | | | | | Grand total. |
|---|---|---|---|---|---|---|---|
| | Labor. | Subsistence. | Fuel. | Expense. | Repairs. | Total. | |
| 1892. | | | | | | | |
| July | $340.00 | | | $21.75 | | $361.75 | $2,479.29 |
| August | 838.02 | $160.90 | $120.69 | 31.32 | $30.94 | 1,181.87 | 3,331.22 |
| September | | 277.53 | 267.20 | 37.93 | 45.13 | 627.79 | 1,806.27 |
| October | 929.34 | 51.32 | 191.51 | 7.46 | | 1,179.63 | 3,262.09 |
| November | | | | 60.15 | 31.62 | 91.77 | 2,779.92 |
| December | | | | | 77.29 | 77.29 | 550.33 |
| 1893. | | | | | | | |
| January | 380.00 | | | 4.00 | | 384.00 | 527.82 |
| February | | | | | | | |
| March | 380.00 | | | | 342.08 | 722.08 | 1,261.82 |
| April | 607.67 | 235.00 | 193.09 | 87.97 | 281.04 | 1,404.77 | 4,285.34 |
| May | | 23.88 | 9.00 | 8.88 | 14.38 | 56.14 | 867.98 |
| June | 850.00 | | | 39.34 | 12.55 | 901.89 | 3,847.92 |
| Total fiscal year | 4,325.03 | 748.63 | 781.49 | 298.80 | 835.03 | 6,988.98 | 25,000.00 |

## REPORT OF MR. C. W. DURHAM, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
*Rock Island, Ill., July 1, 1893.*

MAJOR: I have the honor to present my report on the operations of snag boats and dredge boats on Upper Mississippi River for the fiscal year ending June 30, 1893, together with some statistics of commerce and navigation.

*Operations of snag boat General Barnard.*—The *Barnard*, which had been lying in the Des Moines Rapids Canal during prevalence of high water, was put in commission July 14, and left for above on that day, reaching St. Paul on the 26th. Leveling observations were made at many points on this trip, and also during remainder of the season, with a view of establishing standard high and low water marks and connecting our levels with the precise levels of the Mississippi River Commission. A new wooden gauge was put up at Hastings bridge. Four barges, for construction work between Minneiska and Lacrosse, were towed from Rock Island to Queens Bluff.

On July 27 the *Barnard* returned down the river, reaching St. Louis August 10. On this trip snags and other obstructions were removed at or near the following localities: Grey Cloud, Trenton, Blacksmith Slough, Mount Trempealeau, Lamoille, Raft Channel, Coon Slough, Bad Axe Bend, Glenhaven, Cassville Slough, Arnolds, Hershey Chute, Bay Island, Alexandria, Canton, Hickory Chute, Clarksville, McCoys Island, Sandy Island, and Jersey Landing. Reconnoissances with many soundings were made in the vicinity of Genoa, at Iowa Slough, at the heads of all sloughs between De Soto and Heytmans; between Island 162 and foot of Valley Crossing, at the Picnic Grounds above Dubuque, and in Hamburg Bay.

On August 12 the *Barnard* again started up river, and arrived at St. Paul September 10. On this trip snagging work was done at or near Portage, Squaw Island, Enterprise Island, Natchet Chute, McCanns, Beeks, Cuivre Island, Stag Island, Thomas Chute, Island 472, Clarksville, Mundys, Marion City, Fabius Island Chute, Gregorys, Pontoosuc, Dallas Chute, Shokokon Slough, Skunk River, Sauerweins, Rush Island, Edwards River, Hershey Chute, Benton Island, Huron Island, Bay Island, Sabula, Arnolds, Smiths Ferry, Gordons Ferry, Maquoketa Slough, Prairie du Chien, Crooked Slough, Coon Slough, Root River, Dakota, and Redwing. On this trip dredge *Ajax* was towed from Keokuk to Rock Island, and surveys were made at Santa Fe, Kings Coulee, and Lake City Pier.

On September 12 an attempt was made to go to Minneapolis, but the *Barnard* was obliged to turn back at Minnehaha on account of the great number of running logs in the river.

On September 13 the *Barnard* returned down river, and arrived at St. Louis September 23. Leaving St. Louis September 24, she again reached St. Paul October 14. On this round trip work was performed at or near Diamond Bluff, Redwing, Minneiska, Betsy Slough, Blacksmith Slough, Richmond Slough, Twin Islands, Nigger Chute, Hickory Chute, Clarksville, Reds, Thomas Chute, Tisdales, McCoys Island, Bayou St. Charles, Fabius Island, Ortons Island, Benton Island, Elk River, Hurricane Island, Coon Slough, Picayune Island, and Rollingstone. On this trip the wing dams at Santa Fe were located, a wreck at Muscatine Landing was removed, and a survey at Pine Bend made.

On October 15 the *Barnard* ran up river as far as the Franklin Avenue Bridge, at which point she was obliged to turn back on account of the swift current.

The *Barnard* left St. Paul October 17, reached St. Louis October 29, returned to Keokuk November 3, and was laid up in the canal for the winter November 6. On this trip snagging work was performed at or near St. Paul, Grey Cloud, Horse Shoe Bend, Minneiska, Gregorys, Turtle Island, Tisdales, Thomas Chute, Hamburg, Reds, Piasa Dam, Masons Island, and Cuivre Island.

In 1893, the *Barnard*, having been repainted, and having received ordinary repairs, was put in commission April 10. On April 10 and 11 the floating boom connecting the lower lock with the Keokuk Bridge was put in position. On the afternoon of the 11th she started up river, arriving at Rock Island on the 15th, and thence returning, reached St. Louis on the 21st. Leaving St. Louis on the 22d, the *Barnard* reached Keokuk on the 26th, and remained there until May 2. On above trip she removed snags and other obstructions at or near Keithsburg, Bay Island, Port Louisa, Tully Island, Reds Landing, Slim Island, Amaranth Island, and Blackbird Island.

From May 2 to 20 the *Barnard* was in the employ of the Mississippi River Commission, and made an inspection trip to New Orleans and returned to St. Louis. She left St. Louis for up-river May 22, and reached St. Paul June 5, and returning thence, arrived at Rock Island on the 17th. On this trip work was performed at or near Diamond Bluff, Mount Vernon, Picayune Island, Broken Arrow Island, Coon Slough, De Soto, Yellow River, Wyalusing, Cassville Slough, Royal Arch, Goldens, Sabula, and Clinton.

On June 19 the *Barnard* ran up-river to Hampton and laid up until end of month, her crew being employed on survey work.

*Summary of operations of snag boat General Barnard for the fiscal year ending June 30, 1893.*

| | |
|---|---|
| Snags removed | 341 |
| Leaning trees pulled back | 87 |
| Leaning trees felled | 2,285 |
| Wreck removed | 1 |
| Steamboats assisted | 3 |
| Gauges established | 6 |
| Surveys and examinations made | 7 |
| Miles run | 6,112 |

*Operations of snag boat J. G. Parke, dredge Phœnix, and tow boat Success.*—On account of high water, the *Parke* was not put in commission until August 2, from which date until August 9 she was employed in towing for construction work in the vicinity of La Grange. On the 10th she started down-river with dredge *Phœnix*, one dump, and a coal flat in tow, and arrived at the barge wreck, at head of Iowa Island, August 12. The removal of this dangerous wreck was completed on August 17. On the 18th, commenced removal of towhead below Piasa Dam, completing same on the 20th. On the 22d the dredge was towed to Grafton, and from the bed of the channel opposite that place 6 hardwood logs were removed. These logs are supposed to have sunk the *Charlotte Boeckeler* in 1891. The dredge was next put at work on the wreck of the iron hull *Chapman*, but soon breaking her dipper bail, was laid by for repairs. August 28 to September 1 the *Parke* made an inspection trip from St. Louis to Keokuk and return to Grafton. September 30 dredge commenced work removing barge wreck below Clarksville. The removal of this wreck was completed September 6, and that of the *Home*, just above Clarksville, on the 8th. On the 9th and 10th the dredge deepened the landing place at the stone quarry below Louisiana Bridge.

From September 11 until October 21 the *Parke* was employed towing for construction work in vicinity of Reds Landing and foot of Hickory Chute; October 26 to November 5 with dredge *Phœnix* removing clay and bowlders from channel below Keithsburg. From November 5 until the 18th, when she was laid up in Des Moines Rapids Canal for the winter, the *Parke* was employed in placing portions of the plant in winter quarters at Keokuk, towing dredge *Ajax* and barges from Rock Island, and the greater part of the lower river construction fleet from Hannibal.

Towboat *Success* took dredge *Phœnix* in tow September 11, and they were employed until the 15th in removing towhead at Whitneys Crossing. The *Success* was later employed in raising the sunken steamer *Mary Morton*.

In 1893, the *Parke* having received ordinary repairs, was put in commission April 16, and from that time until June 30 was employed on construction work on Rock Island Rapids.

*Summary of operations of snag boat J. G. Parke, dredge Phœnix, and tow boat Success, when employed in snag-boat service, during fiscal year ending June 30, 1893.*

| | |
|---|---|
| Snags removed | 31 |
| Leaning trees pulled back | 20 |
| Wrecks removed | 4 |
| Towhead | 2 |
| Steamboats assisted | 2 |
| Channels and landings improved | 2 |

A large quantity of bowlders and clay was removed from channel below Keithsburg.

*River notes.*—The river, which continued very high during May and June, 1892, did not fall to a medium stage until the middle of July. From this time until end of season there was a fair stage of water, and boats and rafts had little difficulty. Altogether the season of 1892 was the most favorable for navigation in many years, while that of 1891 was the worst since 1864. In 1893 the river remained at a high or good boating stage until June 30. On account of high water improvement work was much retarded.

### STATISTICS OF COMMERCE AND NAVIGATION.

*Lumber.*—The most important business carried on in connection with the navigation of the Upper Mississippi River and its principal tributaries is the lumber trade, which gave employment in 1892 to about 100 towboats, valued at $750,000. Along the river from Minneapolis to St. Louis 87 saw-mills were operated by 71 wholesale lumber firms having an invested capital of about $40,000,000. Their manufactures in 1892 were: Lumber, 1,420,530,929 feet, B.M.; shingles, 563,397,275; lath, 349,934,540. This shows an increase in manufacture over 1891 of: lumber, 158,588,970; shingles, 23,409,525; lath, 44,513,590. This increase in manufacture was due in a great measure to the excellent condition of the river during the season, which facilitated the rafting of logs down the river.

In addition to the manufacturers, there are a large number of retail or distributing firms.

*Lumber manufacture Upper Mississippi River Valley, 1892.*

| Locality. | Lumber. | Shingles. |
|---|---|---|
| | *Feet, B. M.* | *Number.* |
| Minneapolis | 488,724,624 | 206,362,500 |
| St. Paul to St. Louis | 931,806,305 | 357,014,775 |
| St. Croix River | 175,991,427 | 66,099,750 |
| Black River | 240,678,500 | 127,955,500 |
| Chippewa River | 298,833,782 | 177,189,500 |
| Total | 2,136,034,638 | 934,622,025 |

The larger part of the above was floated for greater or less distances on the Mississippi River, either as logs or lumber.

*Steamboats and freight.*—The principal steamboat lines on the Upper Mississippi River are the Diamond Jo Line, the Eagle Packet Company, and the Joy Lumber Line. There are also many independent boats carrying freight and passengers. During season of 1892 the amount of freight and number of passengers carried on boats and barges could not be accurately ascertained, but partial reports give 195,086 tons of freight and 164,201 passengers, not including those of ferry and excursion boats.

Taking into consideration the logs and lumber floated in the stream, the gross tonnage for 1892 was approximately 4,500,000 tons.

*Statement of amount of freight received at and shipped from St. Louis by the Upper Mississippi, including logs and lumber, for four years.*

| St. Louis. | 1892. | 1891. | 1890. | 1889. |
|---|---|---|---|---|
| | *Tons.* | *Tons.* | *Tons.* | *Tons.* |
| Received | 265,655 | 232,955 | 261,900 | 241,000 |
| Shipped | 51,595 | 18,630 | 22,547 | 47,560 |
| Total | 317,250 | 251,585 | 284,447 | 288,560 |

*Arrivals at and departures from St. Louis during 1892.*

| | |
|---|---|
| Steamboats and barges from Upper Mississippi River arrived at St. Louis | 960 |
| Steamboats and barges departed from St. Louis for Upper Mississippi River | 968 |

*Lumber manufacture on the Mississippi River from St. Paul to St. Louis for seven years.*

| Year. | Lumber. | Shingles. | Lath. |
|---|---|---|---|
| | *Feet, B. M.* | *Number.* | *Number.* |
| 1892 | 931,806,305 | 357,014,775 | 228,042,910 |
| 1891 | 814,228,707 | 332,666,750 | 207,723,350 |
| 1890 | 1,231,678,960 | 508,986,705 | ............ |
| 1889 | 1,044,555,298 | 463,132,700 | ............ |
| 1888 | 1,048,951,386 | 423,655,050 | ............ |
| 1887 | 988,361,094 | 363,239,750 | ............ |
| 1886 | 934,735,854 | 274,581,750 | 267,888,340 |
| Total | 6,994,317,604 | 2,723,277,480 | ............ |

*Statement of distribution of lumber manufacture along the Upper Mississippi River from Minneapolis to St. Louis in 1892.*

| Locality. | Lumber. | Shingles. | Lath. |
|---|---|---|---|
| | *Feet, B. M.* | *Number.* | *Number.* |
| Minneapolis | 488,724,624 | 206,382,500 | 121,891,630 |
| Hastings | 6,500,000 | 3,000,000 | 2,000,000 |
| Redwing | 9,000,000 | 4,000,000 | 750,000 |
| Alma | 1,065,000 | 1,600,000 | 145,000 |
| Winona | 146,000,000 | 98,800,000 | 44,200,000 |
| Lansing | 12,000,000 | 6,500,000 | 2,250,000 |
| Prairie du Chien | 15,231,700 | 7,164,500 | 2,462,400 |
| Guttenburg | 12,000,000 | 4,500,000 | 3,500,000 |
| Dubuque | 58,000,000 | 23,350,000 | 10,000,000 |
| Bellevue | 4,500,000 | ............ | 2,200,000 |
| Lyons | 67,844,000 | 18,838,000 | 17,102,000 |
| Clinton | 195,245,605 | 59,864,275 | 29,620,760 |
| Fulton | 16,200,000 | 7,200,000 | 3,250,000 |
| Moline | 38,500,000 | 4,000,000 | 6,770,000 |
| Davenport | 62,850,000 | 10,125,000 | 13,725,000 |
| Rock Island | 102,350,000 | 47,841,000 | 28,546,000 |
| Muscatine | 59,500,000 | 13,150,000 | 13,738,000 |
| Burlington | 27,680,000 | 9,000,000 | 21,000,000 |
| Fort Madison | 24,000,000 | 15,750,000 | 7,720,000 |
| Keokuk | 14,000,000 | 7,000,000 | 3,000,000 |
| Quincy | 28,500,000 | 15,187,000 | 7,290,000 |
| Canton | 5,640,000 | 7,145,000 | 2,573,750 |
| Hannibal | 25,200,000 | 14,000,000 | 6,200,000 |
| Total | 1,420,530,929 | 563,397,275 | 349,934,540 |

*Statement of steamers, barges, and rafts passing through various bridges.*

| Locality of bridge. | Steamboats. | | | Barges. | | | Rafts. | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1892. | 1891. | 1890. | 1892. | 1891. | 1890. | 1892. | 1891. | 1890. |
| Hastings | 601 | 503 | 454 | 579 | 510 | 341 | 86 | 43 | 45 |
| Winona | 5,268 | 3,687 | 5,417 | 957 | 1,108 | 1,045 | 1,759 | 1,495 | 2,123 |
| Lacrosse | 4,984 | 3,547 | 4,738 | 1,047 | 568 | 626 | 1,901 | 1,265 | 1,926 |
| Dubuque | 3,385 | 2,649 | 3,479 | 1,458 | 1,190 | 1,418 | 736 | *585 | *900 |
| Sabula | 3,247 | 2,844 | 3,244 | 1,240 | 613 | 1,275 | *20 | *20 | 1,547 |
| Clinton | 3,253 | 2,821 | 3,084 | 719 | 622 | 662 | *423 | *602 | *536 |
| Rock Island | 1,847 | 2,694 | 3,122 | 1,805 | 571 | 650 | 756 | 634 | 843 |
| Burlington | 1,759 | 1,620 | 1,750 | 533 | 751 | 767 | 494 | 411 | 317 |
| Keokuk | 2,687 | 1,209 | 1,597 | 2,640 | 420 | 685 | 201 | 165 | 206 |
| Quincy | 2,050 | 1,604 | 1,956 | 784 | 615 | 807 | 291 | 189 | 278 |
| Hannibal | 1,775 | 1,637 | 1,941 | 650 | 590 | 453 | 396 | 319 | 500 |
| Louisiana | 968 | 944 | 989 | 530 | 590 | 408 | 103 | 66 | 166 |

* Partial record.

*Internal revenue for the year ending December 31, 1892.*

| District. | Office. | Amount. |
|---|---|---|
| Minnesota | St. Paul | $2,634,781.42 |
| Second Wisconsin | Madison | 507,270.81 |
| Third Iowa | Dubuque | 178,678.26 |
| Fourth Iowa | Burlington | 327,202.60 |
| Fifth Illinois | Peoria | 21,731,281.76 |
| Aggregate | | 24,731,281.85 |

*Customs revenue and tonnage for the year ending December 31, 1892.*

| Port. | Collections. | Tonnage enrolled. | Vessels. |
|---|---|---|---|
| St. Louis, Mo.* | $1,311,739.65 | 180,587.63 | 209 |
| Burlington, Iowa | 2.74 | 3,587.86 | 33 |
| Rock Island, Ill | | 5,832.82 | 57 |
| Dubuque, Iowa | 13,225.09 | 529,857.00 | 22 |
| Galena, Ill | .35 | 97.63 | 2 |
| Lacrosse, Wis | 98.36 | 4,756.49 | 58 |
| St. Paul, Minn | 424,177.40 | 2,443.70 | 30 |
| Total | 1,869,238.49 | 676,731.12 | 410 |

* Only a part of the St. Louis statement applicable to the Upper Mississippi.

Very respectfully, your obedient servant,

C. W. DURHAM,
*Assistant Engineer.*

Maj. A. MACKENZIE,
*Corps of Engineers, U. S. A.*

## Z 2.

## IMPROVEMENT OF MISSISSIPPI RIVER BETWEEN MOUTH OF MISSOURI RIVER AND MINNEAPOLIS.

Under the head of improving Mississippi River from the mouth of the Ohio to Minneapolis, the river and harbor act of July 13, 1892, allots $600,000 for work between the Missouri River and Minneapolis, and the sundry civil act of March 3, 1893, contains a further allotment of $866,666.67, available July 1, 1893, for the same purpose. I have, therefore, in this report, combined under one head reports on general improvements between those limits. Under this head of appropriation are carried on works for the permanent improvement of through navigation. These works, which have been fully described in previous reports, consist in constructions of rock, brush, piles, and gravel, which close side chutes and properly contract the low-water channel, and in the protection of caving banks by use of the same materials. Between Minneapolis and St. Paul, in addition to works of construction, bowlders are removed and channels dredged through gravel bars; at Rock Island Rapids guide piers, to aid in the navigation of the rapids at night, are built, and rock ledges above grade within the proposed channel limits are removed by drilling, blasting, and dredging. The appropriation also provides for a certain amount of dredging and other temporary work for the more rapid and immediate removal of obstructions to navigation.

At the commencement of the fiscal year there was available the sum of $153,120.81, to which was added by river and harbor act of July 13, 1892, $600,000. Work was carried on vigorously in 1892, but owing to the high stage of water prevailing, operations in 1893, to June 30, were much retarded. Under approved projects, work of dam construction, shore protection, and removal of rocks and bowlders has been carried on during the past year by day's labor and Government plant, between Minneapolis and St. Paul, between St. Paul and Lake Pepin, between Minneiska and Lacrosse, at Rock Island Rapids, at vicinity of Keithsburg, Burlington, Dallas, Pontoosuc, Des Moines River, Hannibal, Hickory Chute, Louisiana, and Reeds Landing. By informal agreement, work with private plant was performed between Minneapolis and St. Paul, in dredging and removing rocks and bowlders, and in building dams and shore protections between Reeds and Minneiska. Under formal contract, dams and shore protections were constructed between Reeds and Minneiska, between Genoa and Prairie du Chien, between Glenhaven and Dubuque, between Bellevue and Savanna, between Dubuque and Clinton, and between Keokuk and Quincy.

Repairs were made to the pier at Lake City, the carpenter work being done by days labor, the brush and rock work by informal agreement. The balance of funds ($1,627.85) specially appropriated for this pier by river and harbor act of July 5, 1884, was expended, and a further allotment was made from the general appropriation.

At Burlington harbor no work was found necessary during the year, and the balance ($3,094.38) remaining from the allotment in act of September 19, 1890, is still available.

Surveys and examinations were made in vicinity of Grey Cloud Landing, below Prescott, at Lake City Pier, below Alma, Minneiska to Chimney Rock, Richmond to Lacrosse, vicinity of Queens Bluff, Lacrosse to Brownsville, below Genoa, at Bad Axe Bend, Iowa Slough, De Soto to Heytmans Landing, Gordons Bay to Prairie le Sioux, Eagle Point, Four Mile Island, Santa Fe, Sand Prairie to Arnolds, vicinity of Alexandria, Reeds Landing, Cap au Gris, Piasa Island, and Moline.

The buoys and ranges on the Rock Island Rapids were maintained.

Extensive repairs were made to the plant belonging to this appropriation, and 32 barges, 8 inspector boats, 2 quarter boats, 4 fuel flats, 1 drill boat, 1 pile driver, 2 steam launches, and 2 naphtha launches were added during the year.

The details of all the above-mentioned work are fully given in the appended report of Assistant Engineer C. W. Durham, which includes full extracts from the reports of Superintendents J. D. DuShane, W. A.

Thompson, and J. C. McElherne, and the report of M. Meigs, United States civil engineer, covering that of Superintendent S. Edwards.

*Minneapolis to St. Paul.*—The act of Congress of August 11, 1888, provided in a general way for work of improvement between Minneapolis and St. Paul; but the act of September 19, 1890, allotted a specific amount ($50,000) for carrying on specified work in this section of the river. In accordance with the provisions of the act of September 19, 1890, a preliminary project for the commencement of the work of removing bowlders was presented September 30, 1890, and approved October 14, 1890, this project being intended to cover the small amount of work that could be done during remainder of season of 1890, and a complete project was presented February 23, 1891, and approved February 28, 1891. The latter project proposed a continuation of the work of removing bowlders, the construction of dams and revetments, and the dredging of gravel bars. A large part of this work was carried out in 1891 and 1892, but with a channel, as now existing, of sufficient depth and free from obstruction, it was found by actual trial to be very difficult, if not impossible, for large boats to stem the current at the swifter portions of the rapids between Meekers Island and Minneapolis. In fact the velocity of the current is such as to practically prevent profitable navigation.

As stated in former reports, I am of the opinion that, while the lower portion of the stretch of river here considered may be made as favorable for navigation as the river below St. Paul by the work proposed, the upper portion, or rapids, can only be radically improved by the construction of locks and dams.

There is available for this work from the appropriation of 1890, $4,583.83, and a further sum of $50,000 from the appropriation of July 13, 1892.

It would not, in my judgment, be wise to continue general work of removing bowlders and dredging at the rapids, but a large portion, if not all, of the above amounts can be used to advantage in dam and shore protection work between Meekers Island and St. Paul, and in dredging through gravel bars and at landings.

Under date of February 15, 1893, I was directed by the Chief of Engineers to prepare new and exact estimates for locks and dams for this portion of the river and to submit to him the results, when reached. Surveys will be made when the water reaches a suitable stage, it having remained so high thus far as to prohibit advantageous work in the field, and estimates will be prepared as soon thereafter as practicable.

*Adams Flume.*—The river and harbor act of July 13, 1892, contains the following clause:

> The Secretary of War is hereby directed to pay, out of the sum allotted to the river between the mouth of the Missouri River and Minneapolis, to M. J. Adams, $5,000 in full of all claims and demands growing out of the test made by him of what is known as the Adams Flume on the Upper Mississippi River, the said test having been authorized by Congress.

This sum was paid to Mr. Adams, making the amount expended on this so-called test, $35,176.33. The Adams Flume is a supposed device for deepening and widening river channels by forcing water through perforated pipes placed on the bottom, but no pipes were ever placed in the river and *no test* was ever made.

*Improving Quincy Bay, Illinois.*—The river and harbor act of July 13, 1892, contains the following clause:

> Improving Quincy Bay, Illinois.—The balance on hand to credit of this improvement from the appropriation made in the river and harbor act of September nine-

**teenth, eighteen hundred and ninety, is hereby authorized to be expended, or so much thereof as may be necessary, in constructing a retaining levee on Whipple Creek Bar to hold the material dredged from the bay, as recommended by the engineer in charge in the report for eighteen hundred and ninety-one, page twenty-one hundred and twenty-one.**

A project for a retaining levee or bulkhead on Whipple Creek Bar was submitted February 25, 1893, and approved March 3, 1893. Contract for the work was let to Mr. H. S. Brown, the lowest bidder. The construction of the bulkhead was commenced in June, and is now in progress. Details may be found in the report of M. Meigs, United States civil engineer.

Commercial statistics relating to the Upper Mississippi River are given in connection with the report on "operating snag boats and dredge boats on Upper Mississippi River." These statistics do not fully indicate the relations of this work to the interests of commerce and the general public. The influence which the Upper Mississippi River in an improved condition has upon freight rates must be taken as a measure of its importance. Of the amount of freight carried by railroads at river rates, as a result of the river competition, no figures can be given; but such amount is known to be very large during the season when navigation of the river is practicable.

During the past year the works heretofore constructed by the Government have continued to straighten and deepen the low-water channel of the river and to materially benefit the interests of commerce and navigation. That such benefit should continue and increase, it is necessary that the work of improvement be continued until the whole river is put under such control that the possibility of new obstructions appearing is done away with.

If the radical improvement of the Upper Mississippi River is to be continued and carried to the full limits which the immense interests involved justify, it is desirable that it should be carried on under liberal appropriations, so that the full benefit of the improvement may be secured at as early a day as is practicable. As an amount that can be profitably expended during the fiscal year ending June 30, 1895, I present an estimate of $866,666.67.

The improvement of the Upper Mississippi River is a work which can be best carried on so gradually as to give the river itself full opportunity to assist in the formation of proper channels, and, if carried to its fullest limits, the work must extend over many years. It does not now appear desirable, or even practicable, to prepare detailed plans for the whole river so long in advance of the time when it may be possible or necessary to carry out some of the work. The existing project for this work may therefore be said to be one of general methods and the execution of detailed plans for special localities. Under the conditions named no detailed estimates of cost of completing the entire work can well be now made. Projects for the expenditure of each appropriation, in accordance with approved plans and methods, are presented in lieu of a general project for the completion of. work. It has been the custom in carrying out work on the Upper Mississippi to select, when funds are available, such localities for improvement as may be at the time most detrimental to navigation. Each and every locality thus improved has a beneficial result on the navigation of the whole river, and, as the shoalest bars have been improved from year to year, the ruling navigable depth has been considerably increased. By this method the good effects of work are spread over the entire stretch of river, and the improvement of the river, considered as a whole, is made progressive, the expenditure of each successive appropriation resulting in further and immediate benefit to the interests of continuous navigation.

*Summary of expenditures for calendar year ending December 31, 1892, under appropriations for improving Mississippi River, "Ohio River to Minneapolis," applied to that portion of the river between the mouth of the Missouri River and Minneapolis, "Minneapolis to Des Moines Rapids," "St. Paul to Des Moines Rapids," and "Des Moines Rapids to Illinois River."*

| | |
|---|---|
| Minneapolis to St. Paul | $19,210.22 |
| St. Paul to Lake Pepin | 39,084.47 |
| Repairing Lake City Pier | 2,711.87 |
| Reeds Landing to Minneiska | 29,645.09 |
| Minneiska to Lacrosse | 50,227.84 |
| Bellevne to Savanna | 17,670.88 |
| Dubuque to Clinton | 5,685.73 |
| Rock Island Rapids | 15,399,42 |
| Keithsburg to Montrose | 32,724.85 |
| Buoys on Rock Island Rapids | 398.66 |
| Removing bowlders from channel below Keithsburg | 1,002.84 |
| Keokuk to Hannibal | 26,779.43 |
| Hannibal to Illinois River | 17,410.38 |
| Purchase, construction, care and repair of plant | 31,820.66 |
| Surveys and gauges | 6,210.27 |
| Total | 295,982.61 |

NOTE.—In above statement retained percentages on contracts and other liabilities outstanding December 31, 1892, are included.

*Abstract of appropriations.*

| | |
|---|---|
| St. Paul to Des Moines Rapids: | |
| By act approved— | |
| June 18, 1878 | $250,000.00 |
| March 3, 1879 | 100,000.00 |
| June 14, 1880 | 150,000.00 |
| March 3, 1881 | 200,000.00 |
| By act passed August 2, 1882 | 250,000.00 |
| By act approved— | |
| July 5, 1884 (general improvement) | 250,000.00 |
| July 5, 1884 (applied to harbor Lake City) | 15,000.00 |
| August 5, 1886 | 382.500.00 |
| Minneapolis to Des Moines Rapids: | |
| By act of August 11, 1888 | 600,000.00 |
| By act of September 19, 1890 | 500,000.00 |
| Des Moines Rapids to Illinois River: | |
| By act approved— | |
| June 18, 1878 | 100,000.00 |
| March 3, 1879 | 40,000.00 |
| June 14, 1880 | 100,000.00 |
| March 3, 1881 | 175,000.00 |
| By act passed August 2, 1882 | 200,000.00 |
| By act approved— | |
| July 5, 1884 | 200,000.00 |
| August 5, 1886 | 150,000.00 |
| By act of August 11, 1888 | 200,000.00 |
| By act of September 19, 1890 | 165,000.00 |
| Ohio River to Minneapolis, applied to Missouri River to Minneapolis: | |
| By act approved— | |
| July 13, 1892 | 600,000.00 |
| March 3, 1893 (civil sundry) | 866,666.67 |
| Total | 5,494,166.67 |

*General statement showing net expenditures from the commencement of improvement to July 1, 1893, under various appropriations.*

| | | |
|---|---|---|
| St. Paul to Des Moines Rapids | | $1,560,323.17 |
| Practical test of Adams Flume (St. Paul to Des Moines Rapids) | | *22,176.83 |
| Harbor at Lake City (St. Paul to Des Moines Rapids) | | 15,000.00 |
| Minneapolis to Des Moines Rapids | | 1,092,319.79 |
| Des Moines Rapids to Illinois River | | 1,318,012.45 |
| Ohio River to Minneapolis (applied to "between mouth of Missouri River and Minneapolis") | | 268,488.23 |
| Total net expenditures | | 4,276,320.47 |
| Balances July 1, 1893— | | |
| Minneapolis to Des Moines Rapids | †$7,680.21 | |
| Des Moines Rapids to Illinois River | ‡11,987.55 | |
| Ohio River to Minneapolis | 1,198,178.44 | |
| | | 1,217,846.20 |
| Total appropriated | | 5,494,166.67 |

*Net expenditures on the various sections of the river between Minneapolis and the Missouri River from commencement of improvement to July, 1893.*

| Locality. | Distance. | Amounts. |
|---|---|---|
| | *Miles.* | |
| Minneapolis to St. Paul (Omaha Bridge | 11 | $54,287.72 |
| St. Paul (Omaha Bridge) to Prescott | 32 | 560,251.75 |
| Prescott to head of Lake Pepin | 29 | 84,556.45 |
| Harbor at Lake City | | 16,091.62 |
| Foot of Lake Pepin to Alma | 12 | 328,868.11 |
| Alma to Winona Bridge | 29 | 331,677.73 |
| Winona Bridge to La Crosse Bridge | 31 | 228,682.27 |
| La Crosse Bridge to McGregor Bridge | 72 | 158,794.72 |
| McGregor Bridge to Dubuque Bridge | 59 | 90,139.25 |
| Dubuque Bridge to Clinton Bridge | 67 | 85,332.27 |
| Clinton Bridge to Rock Island Bridge | 40 | 168,310.57 |
| Rock Island Bridge to Keithsburg Bridge | 58 | 70,071,85 |
| Keithsburg Bridge to Des Moines Rapids | 60 | 470,952.71 |
| Keokuk to Quincy Bridge | 40 | 271,867.05 |
| Quincy Bridge to Clarksville | 60 | 476,144.61 |
| Clarksville to Cap au Gris | 43 | 274,730.59 |
| Cap au Gris to Illinois River | 27 | 129,326.90 |
| Quincy Bay* | | 32,194.11 |
| Hamburg Bay | | 10,000.00 |
| Sny Levee | | 52,755.50 |
| Surveys, gauges, and meter work | | 145,080.77 |
| Snag and dredge boats and wrecking | | 59,661.11 |
| Facilitating navigation through bridges | | 1,412.18 |
| Practical test of Adams Flume | | 27,176.83 |
| Plant at estimated value | | 147,953.80 |
| Total | | 4,276,320.47 |

*Twenty-five thousand dollars additional expended at Quincy Bay under special appropriation.

## ST. PAUL TO DES MOINES RAPIDS.

### *Money statement.*

| | |
|---|---|
| July 1, 1892, balance available, Lake City Harbor | $1,627.85 |
| June 30, 1893, amount expended during fiscal year | 1,627.85 |

---

* In addition to this amount Mr. Adams expended $13,000 appropriated by acts of August 2, 1882, and July 13, 1892.

† Of this balance, $4,585.83 pertains to Minneapolis to St. Paul, and $3,094.38 to harbor at Burlington, Iowa.

‡ This balance pertains to Quincy Bay, Illinois.

### MINNEAPOLIS TO DES MOINES RAPIDS.

### *Money statement.*

| | | |
|---|---|---|
| July 1, 1892, balance unexpended: | | |
| General improvement | | $111, 758.34 |
| Between Chicago, St. Paul, Minneapolis and Omaha Railroad Bridge and Washington Avenue Bridge | | 19, 973.50 |
| Harbor at Burlington, Iowa | | 3, 094.38 |
| | | 134, 826.22 |
| June 30, 1893, amount expended during fiscal year: | | |
| General improvement | $111, 758.34 | |
| Between Chicago, St. Paul, Minneapolis, and Omaha Railroad Bridge and Washington Avenue Bridge | 15, 387.67 | |
| | | 127, 146.01 |
| July 1, 1893, balance unexpended: | | |
| Between Chicago, St. Paul, Minneapolis, and Omaha Railroad Bridge and Washington Avenue Bridge | 4, 585.83 | |
| Harbor at Burlington | 3, 094.38 | |
| | | 7, 680.21 |

### DES MOINES RAPIDS TO ILLINOIS RIVER.

### *Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $60, 863.76 |
| June 30, 1893, amount expended during fiscal year | 48, 876.21 |
| July 1, 1893, balance unexpended | *11, 987.55 |
| July 1, 1893, amount covered by uncompleted contracts | 8, 900.40 |
| July 1, 1893, balance available | 3, 087.15 |

### OHIO RIVER TO MINNEAPOLIS, APPLIED TO THAT PORTION OF THE RIVER BETWEEN THE MOUTH OF MISSOURI RIVER AND MINNEAPOLIS.

### *Money statement.*

| | | |
|---|---|---|
| July 1, 1892, balance unexpended: | | |
| Amount appropriated by act approved July 13, 1892 | | $600, 000.00 |
| Amount appropriated by sundry civil act approved March 3, 1893 | | 866, 666.67 |
| | | 1, 466, 666.67 |
| June 30, 1893, amount expended during fiscal year | | †268, 488.23 |
| July 1, 1893, balance unexpended | | 1, 198, 178.44 |
| July 1, 1893, outstanding liabilities | $13, 135.97 | |
| July 1, 1893, amount covered by uncompleted contracts | ‡258, 522.38 | |
| | | 271, 658.35 |
| July 1, 1893, balance available | | 926, 520.09 |
| Amount (estimated) required for completion of existing project | | Unknown. |
| Amount that can be profitably expended in fiscal year ending June 30, 1895 | | 866, 666.67 |
| Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893. | | |

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* For Quincy Bay.

† Of this amount $5,000 were paid in Washington to M. J. Adams on account of the Adams Flume.

‡ Of this amount $401.73 are nonpayments, and the remainder retained percentage.

*Abstract of proposals received and opened by Maj. A. Mackenzie, Corps of Engineers, at Rock Island, Ill., September 27, 1892, at 2 p. m., for furnishing 20,000 cubic yards of riprap rock on United States barges between Minneapolis and Lake Pepin.*

(There are available for this work from appropriation of $1,125,000 made by the river and harbor act approved July 13, 1892, for "improving Mississippi River between Minneapolis and mouth of Ohio River," under an allotment of $600,000 made by said act for "improving Mississippi River between Minneapolis and mouth of Missouri River," allotments, amounting to $80,000, made by project approved August 9, 1892.)

| No. | Name and residence of bidder. | Riprap Rock to be furnished. | Price per cubic yard. | Total. |
|---|---|---|---|---|
| | | *Cubic yds.* | *Cents.* | |
| 1 | M. Ahern, Chas. Sjogren, Hastings, Minn | 20,000 | 62 | *$12,400 |
| 2 | F. N. Truax, St. Paul Park, Minn | 5,000 | 65 | 3,250 |
| 3 | John Killeen, New Liberty, Iowa | 20,000 | 80 | 16,000 |

*Accepted, and written contract made.

*Abstract of proposals received and opened by Maj. A. Mackenzie, Corps of Engineers, at Rock Island, Ill., September 27, 1892, at 2 p. m., for furnishing 30,000 cubic yards of brush on United States barges between Minneapolis and Lake Pepin.*

(There are available for this work from appropriation of $1,125,000 made by the river and harbor act approved July 13, 1892, for "improving Mississippi River between Minneapolis and mouth of Ohio River," under an allotment of $600,000, made by said act for "improving Mississippi River between Minneapolis and mouth of Missouri River," allotments, amounting to $80,000, made by project approved August 9, 1892.)

| No. | Name and residence of bidder. | Brush to be furnished. | Price per cubic yard. | Total. |
|---|---|---|---|---|
| | | *Cubic yds.* | *Cents.* | |
| 1 | Matthew Ahern, Hastings, Minn | 30,000 | 38 | $11,400 |
| 2 | Herbert Ames, St. Paul Park, Minn | 10,000<br>20,000 | 35½<br>37 | *3,550<br>7,400 |
| 3 | Frank N. Truax, St. Paul Park, Minn | 10,000 | 32½ | *3,250 |
| 4 | E. Du Shane, Hastings, Minn | 5,000 | 42 | 2,000 |
| 5 | John Killeen, New Liberty, Iowa | 30,000 | 47 | 14,100 |

*Accepted, and written contracts made.

*Abstract of proposals received and opened by Maj. A. Mackenzie, Corps of Engineers, at Rock Island, Ill., September 23, 1892, at 2 p. m., for construction of dams and shore protections on the Mississippi River between Reeds Landing and Minneiska, Minn.*

(There is available for this work from appropriation of $1,125,000 made by the river and harbor act approved July 13, 1892, for "improving Mississippi River between Minneapolis and mouth of Ohio River," under an allotment of $600,000 made by said act for "improving Mississippi River between Minneapolis and mouth of Missouri River," an allotment of $45,000 made by project approved August 9, 1892.)

| No. | Name and residence of bidder. | Rock in place 22,500 cubic yards. | | Brush in place, 22,500 cubic yards. | | Grand total. |
|---|---|---|---|---|---|---|
| | | Per cubic yard. | Total. | Per cubic yard. | Total. | |
| | | | | *Cents.* | | |
| 1 | Albert Kirchner, Fountain City, Wis | $1.40 | $31,500 | 70 | $15,750 | *$47,250 |
| 2 | Jacob Richtman, Fountain City, Wis | 1.53 | 34,425 | 54 | 12,150 | 46,575 |

*Accepted, and written contract made.

*Abstract of proposals received and opened by Maj. A. Mackenzie, Corps of Engineers, at Rock Island, Ill., September 27, 1892, at 2 p. m., for furnishing 35,000 cubic yards of riprap rock on United States barges between Minneiska, Minn., and La Crosse, Wis.*

(There is available for this work from appropriation of $1,125,000 made by the river and harbor act approved July 13, 1892, for "improving Mississippi River between Minneapolis and mouth of Ohio River," under an allotment of $600,000 made by said act for "improving Mississippi River between Minneapolis and mouth of Missouri River," an allotment of $45,000 made by project approved August 9, 1892.)

| No. | Name and residence of bidder. | Riprap rock to be furnished. | Price per cubic yards. | Total. |
|---|---|---|---|---|
| | | *Cubic yards.* | *Cents.* | |
| 1 | Edgar R. Leach, Richmond, Minn | *5,000 | †50<br>‡70 | $2,500<br>3,500 |
| 2 | Albert Kirchner, Fountain City, Wis | §35,000 | ‡53<br>†75 | 18,550<br>26,250 |
| 3 | Thompson & Gray, St. Charles, Mo | 35,000 | 83 | 29,050 |
| 4 | John Killeen, New Liberty, Iowa | 35,000 | 85 | 29,750 |
| 5 | Henry Becker, Dresbach, Minn | 35,000<br>15,000 | †75<br>†60 | 26,250<br>9,000 |

* Accepted, and written contract made.
† Sand rock.
‡ Lime rock.
§ Thirty thousand cubic yards accepted, and written contract made.

*Abstract of proposals received and opened by Maj. A. Mackenzie, Corps of Engineers, at Rock Island, Ill., September 27, 1892, at 2 p. m., for furnishing 40,000 cubic yards of brush on United States barges between Minneiska, Minn., and La Crosse, Wis.*

(There is available for this work from appropriation of $1,125,000 made by the river and harbor act approved July 13, 1892, for "improving Mississippi River between Minneapolis and mouth of Ohio River," under an allotment of $600,000 made by said act for "improving Mississippi River between Minneapolis and mouth of Missouri River," an allotment of $45,000 made by project approved August 9, 1892.)

| No. | Name and residence of bidder. | Brush to be furnished. | Price per cubic yard. | Total. |
|---|---|---|---|---|
| | | *Cubic yards.* | *Cents.* | |
| 1 | Jacob Schmoker, Fountain City, Wis | 40,000 | 30½ | *$12,200 |
| 2 | Thompson & Gray, St. Charles, Mo | 40,000 | 35 | 14,000 |
| 3 | John Killeen, New Liberty, Iowa | 40,000 | 50 | 20,000 |

* Accepted, and written contract made.

*Abstract of proposals received and opened by Maj. A. Mackenzie, Corps of Engineers, at Rock Island, Ill., September 23, 1892, at 2 p. m., for construction of dams and shore protections on the Mississippi River between Genoa and Prairie du Chien, Wis.*

(There is available for this work from appropriation of $1,125,000 made by the river and harbor act approved July 13, 1892, for "improving Mississippi River between Minneapolis and mouth of Ohio River," under an allotment of $600,000 made by said act for "improving Mississippi River between Minneapolis and mouth of Missouri River," an allotment of $50,000 made by project approved August 9, 1892).

| No. | Name and residence of bidder. | Rock in place, 25,000 cubic yards. | | Brush in place, 25,000 cubic yards. | | Grand total. |
|---|---|---|---|---|---|---|
| | | Per cubic yard. | Total. | Per cubic yard. | Total. | |
| | | | | *Cents.* | | |
| 1 | Albert Kirchner, Fountain City, Wis | $1.40 | $35,000 | 66 | $16,500 | *$51,500 |
| 2 | Sid J. Truax, Hastings, Minn | 1.38 | 34,500 | 68 | 17,000 | 51,500 |
| 3 | Jacob Richtman, Fountain City, Wis | 1.53 | 38,250 | 54 | 13,500 | 51,750 |

* Accepted, and written contract made.

*Abstract of proposals received and opened by Maj. A. Mackenzie, Corps of Engineers, at Rock Island, Ill., September 23, 1892, at 2 p. m., for construction of dams and shore protections on the Mississippi River between Glenhaven, Wis., and Dubuque, Iowa.*

(There is available for this work from appropriation of $1,125,000, made by the river and harbor act approved July 13, 1892, for "improving Mississippi River between Minneapolis and mouth of Ohio River," under an allotment of $600,000 made by said act for "improving Mississippi River between Minneapolis and mouth of Missouri River," an allotment of $50,000 made by project approved August 9, 1892.)

| No. | Name and residence of bidder. | Rock in place, 25,000 cubic yards. |  | Brush in place, 25,000 cubic yards. |  | Grand total. |
|---|---|---|---|---|---|---|
|  |  | Per cubic yard. | Total. | Per cubic yard. | Total. |  |
|  |  |  |  | *Cents.* |  |  |
| 1 | A. J. Whitney, Rock Island, Ill | $1.40 | $35,000 | 59 | $14,750 | *$49,750 |
| 2 | Sid J. Truax, Hastings, Minn | 1.45 | 36,250 | 75 | 18,750 | 55,000 |
| 3 | Jacob Richtman, Fountain City, Wis | 1.53 | 38,250 | 54 | 13,500 | 51,750 |
| 4 | Patterson Bros., Keokuk, Iowa | 1.45 | 36,250 | 62 | 15,500 | 51,750 |

*Accepted, and written contract made.

*Abstract of proposals received and opened by Maj. A. Mackenzie, Corps of Engineers, at Rock Island, Ill., September 23, 1892, at 2 p. m., for construction of dams and shore protections on the Mississippi River between Dubuque, Iowa, and Clinton, Iowa.*

(There is available for this work from appropriation of $1,125,000, made by the river and harbor act approved July 13, 1892, for "improving Mississippi River between Minneapolis and mouth of Ohio River," under an allotment of $600,000 made by said act for "improving Mississippi River between Minneapolis and mouth of Missouri River," an allotment of $50,000 made by project approved August 9, 1892.)

| No. | Name and residence of bidder. | Rock in place, 25,000 cubic yards. |  | Brush in place, 25,000 cubic yards. |  | Grand total. |
|---|---|---|---|---|---|---|
|  |  | Per cubic yard. | Total. | Per cubic yard. | Total. |  |
|  |  |  |  | *Cents.* |  |  |
| 1 | A. J. Whitney, Rock Island, Ill | $1.40 | $35,000 | 60 | $15,000 | $50,000 |
| 2 | Jacob Richtman, Fountain City, Wis | 1.53 | 38,250 | 54 | 13,500 | 51,750 |
| 3 | Patterson Bros., Keokuk, Iowa | 1.40 | 35,000 | 59 | 14,750 | *49,750 |

*Accepted, and written contract made.

*Abstract of proposals received and opened by Maj. A. Mackenzie, Corps of Engineers, at Rock Island, Ill., September 27, 1892, at 2 p. m., for furnishing 17,000 cubic yards of riprap rock, and 1,700 cubic yards of slope-wall rock in vicinity of Rock Island Rapids*

(There is available for this work from appropriation of $1,125,000, made by the river and harbor act approved July 13, 1892, for "improving Mississippi River between Minneapolis and mouth of Ohio River," under an allotment of $600,000 made by said act for "improving Mississippi River between Minneapolis and mouth of Missouri River," an allotment of $25,000 made by project approved August 9, 1892.)

| No. | Name and residence of bidder. | Riprap rock, 17,000 cubic yards. |  | Slope-wall rock, 1,700 cubic yards. |  | Grand total. |
|---|---|---|---|---|---|---|
|  |  | Per cubic yard. | Total. | Per cubic yard. | Total. |  |
|  |  | *Cents.* |  |  |  |  |
| 1 | Edw. Edinger, Davenport, Iowa | 85 | $14,450 | $3.25 | $5,525 | $19,975 |
| 2 | John Killeen, New Liberty, Iowa | 85 | 14,450 | 1.95 | 3,315 | 17,765 |
| 3 | D. M. Richardson, S. Monroe, Portsmouth, Ohio | 67 | 11,390 | 2.10 | 3,570 | *14,960 |
| 4 | Velie & Nason, Moline, Ill | 70 | 11,900 | 2.35 | 3,995 | 15,895 |

*Accepted, and written contract made.

*Abstract of proposals received and opened by Maj. A. Mackenzie, Corps of Engineers, at Rock Island, Ill., September 27, 1892, at 2 p. m., for furnishing 20,000 cubic yards of riprap rock on United States barges between Keithsburg, Ill., and Montrose, Iowa.*

(There is available for this work from appropriation of $1,125,000, made by the river and harbor act approved July 13, 1892, for "improving Mississippi River between Minneapolis and mouth of Ohio River," under an allotment of $600,000 made by said act for "improving Mississippi River between Minneapolis and mouth of Missouri River," an allotment of $35,000 made by project approved August 9, 1892.)

| No. | Name and residence of bidder. | Riprap rock to be furnished. | Price per cubic yard. | Total. |
|---|---|---|---|---|
| | | *Cub. yds.* | *Cents.* | |
| 1 | Christian Mathes, Burlington, Iowa | 6,000 | 90 | $5,400 |
| 2 | Perry Becker, Pontoosuc, Ill | 2,000 | 78 | 1,560 |
| 3 | William Engelhard, Pontoosuc, Ill | 5,000 | 78 | *3,900 |
| 4 | Chas. B. Hutson, Perry Siens, Pontoosuc, Ill | 5,000 | 90 | 4,500 |
| 5 | Thompson & Gray, St. Charles, Mo | 20,000 | 94 | 18,800 |
| 6 | John Killeen, New Liberty, Iowa | 20,000 | 85 | 17,000 |
| 7 | Wm. Roberts, Nauvoo, Ill | 10,000 | 87½ | 8,750 |
| 8 | D. M. Richardson and S. Monroe, Portsmouth, Ohio | 20,000 | 87 | 17,400 |

*Accepted, and written contract made.

*Abstract of proposals received and opened by Maj. A. Mackenzie, Corps of Engineers, at Rock Island, Ill., September 27, 1892, at 2 p. m., for furnishing 25,000 cubic yards of brush on United States barges between Keithsburg, Ill., and Montrose, Iowa.*

(There is available for this work from appropriation of $1,125,000, made by the river and harbor act approved July 13, 1892, for "improving Mississippi River between Minneapolis and mouth of Ohio River," under an allotment of $600,000 made by said act for "improving Mississippi River between Minneapolis and mouth of Missouri River," an allotment of $35,000, made by project approved August 9, 1892.)

| No. | Name and residence of bidder. | Brush to be furnished. | Price per cubic yard. | Total. |
|---|---|---|---|---|
| | | *Cubic yds.* | *Cents.* | |
| 1 | Chas. P. Winters, Fort Madison, Iowa | 25,000 | 38½ | $9,625 |
| 2 | Philip Pence, Lomax, Ill | 2,500 | 30 | *750 |
| 3 | William A. Shain, Pontoosuc, Ill | 5,000 | 28 | *1,400 |
| 4 | G. Gasaway and M. Gasaway, Dallas City, Ill | 10,000 | 30 | 3,000 |
| 5 | John T. Graham, Dallas City, Ill | 10,000 | 27 | 2,700 |
| 6 | Thompson & Gray, St. Charles, Mo | 25,000 | 37 | 9,250 |
| 7 | John Killeen, New Liberty, Iowa | 25,000 | 50 | 12,500 |
| 8 | Richardson & Monroe, Portsmouth, Ohio | 25,000 | 37 | 9,250 |

*Accepted, and written contract made.

*Abstract of proposals received and opened by Maj. A. Mackenzie, Corps of Engineers, at Rock Island, Ill., October 18, 1892, at 2 p. m., for construction of dams and shore protections between Keokuk, Iowa, and Quincy, Ill.*

(There is available for this work from appropriation of $1,125,000, made by the river and harbor act approved July 13, 1892, for "improving Mississippi River between Minneapolis and mouth of Ohio River," under an allotment of $600,000 made by said act for "improving Mississippi River between Minneapolis and mouth of Missouri River," an allotment of $100,000, made by project approved September 14, 1892.)

| No. | Name and residence of bidder. | Rock in place, 50,000 cubic yards. | | Brush in place, 50,000 cubic yards. | | Grand total. |
|---|---|---|---|---|---|---|
| | | Per cubic yard. | Total. | Per cubic yard. | Total. | |
| 1 | Thompson & Gray, St. Charles, Mo | $1.37 | $68,500 | $0.47 | $23,500 | *$92,000 |
| 2 | William Kirk, Madison, Ind | 1.65 | 82,500 | .85 | 42,500 | 135,000 |
| 3 | S. J. Truax, Hastings, Minn | 1.59 | 79,500 | .50 | 25,000 | 104,500 |
| 4 | H. S. Brown, Quincy, Ill | 1.50 | 75,000 | .90 | 45,000 | 120,000 |
| 5 | Patterson Bros., Keokuk, Iowa | 1.65 | 82,500 | 1.00 | 50,000 | 132,000 |

*Accepted, and written contract made.

*Abstract of proposals received and opened by Maj. A. Mackenzie, Corps of Engineers, at Rock Island, Ill., January 5, 1893, at 2 p. m., for furnishing and delivering fir and cedar timber at Keokuk, Iowa.*

(There is available for this work, from appropriation of $1,125,000 made by the river and harbor act approved July 13, 1892, for "improving Mississippi River, between Minneapolis and mouth of Ohio River," under an allotment of $600,000 made by said act for "improving Mississippi River, between Minneapolis and the mouth of Missouri River," an allotment of $50,000 made by project approved August 9, 1892.)

| No. | Name and residence of bidder. | Fir timber, 99,858 feet. | | Cedar timber 10,000 feet. | | Grand total. |
|---|---|---|---|---|---|---|
| | | Per M. | Total. | Per M. | Total. | |
| 1 | D. M. Clarkson Lumber Co., Portland, Oregon. | $32.50 | $3,245.39 | $32.50 | $325.00 | $3,570.39 |
| 2 | Tacoma Mill Co., Tacoma, Wash | 29.54 | 2,949.81 | 25.75 | 257.50 | *3,207.31 |
| 3 | North Pacific Lumber Co., Portland, Oregon | ........ | 3,438.25 | 32.50 | 325.00 | 3,763.25 |
| 4 | E. D. Hamlin, Tacoma, Wash | ........ | 3,395.45 | 35.50 | 355.00 | 3,750.45 |
| 5 | Foster & Hastings, Tacoma, Wash | 31.50 | 3,145.53 | 55.00 | 550.00 | 3,695.53 |
| 6 | H. A. Hogue, Portland, Oregon | 35.30 | 3,524.99 | 35.30 | 353.00 | 3,877.99 |
| 7 | Henry K. Gustin, Ann Arbor, Mich | 43.00 | 4,293.89 | 41.00 | 410.00 | 4,703.89 |
| 8 | Fremont Milling Co., Seattle, Wash | 34.00 | 3,395.17 | 34.00 | 340.00 | 3,735.17 |
| 9 | St. Louis Refrigerator & W. G. Co., St. Louis. | 29.25 | 2,920.85 | 29.25 | 292.50 | 3,213.35 |
| 10 | Seatco Manufacturing Co., Chicago, Ill | 30.50 | 3,045.67 | 31.00 | 310.00 | 3,355.67 |

*Accepted, and written contract made.

*Abstract of proposals received and opened by Maj. A. Mackenzie, Corps of Engineers, at Rock Island, Ill., April 8, 1893, at 2 p. m., for construction of pile bulkhead in Quincy Bay, Illinois.*

(There is available for this work, from appropriation of $165,000 made by the river and harbor act approved September 19, 1890, for "improving Mississippi River from Des Moines Rapids to mouth of Illinois River," under an allotment of $25,000 made by said act for "continuing the dredging in Quincy Bay," a balance of allotment of $11,992.05, in accordance with project approved March 3, 1893.)

| No. | Name and residence of bidder. | 20,000 linear feet white oak piling, in place. | | 100,000 feet, B. M., sheet piling, in place. | | 28,000 feet, B. M., waling, in place. | | 4,000 cubic yards gravel filling, in place. | | Grand total. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Per foot. | Total. | Per M feet. | Total. | Per M feet. | Total. | Per cubic yard. | Total. | |
| | | *Cents.* | | | | | | *Cents.* | | |
| 1 | C. Irwin McDonald, Pittsburg, Pa | 49 | $9,800 | $45.00 | $4,500 | $45.00 | $1,260 | 82 | $3,280 | $18,840 |
| 2 | Sid J. Truax, Hastings, Minn | 30 | 6,000 | 35.00 | 3,500 | 35.00 | 980 | 30 | 1,200 | 11,680 |
| 3 | H. S. Brown, Quincy, Ill | ...... | 5,000 | ........ | 1,950 | ........ | 750 | 30 | 1,200 | *8,900 |
| 4 | Diver & Swanwick, Keokuk, Iowa | 25 | 5,000 | 25.00 | 2,500 | 25.00 | 700 | 28 | 1,120 | 9,320 |
| 5 | R. L. Van Sant and R. P. Lutes, St. Louis, Mo | 28 | 5,600 | 27.50 | 2,750 | 27.50 | 770 | 35 | 1,400 | 10,520 |
| 6 | Walter B. Gelatt, Columbus Junction, Iowa | 30 | 6,000 | 50.00 | 5,000 | 25.00 | 700 | 33.5 | 1,340 | 13,040 |

*Accepted, and written contract made.

## REPORT OF MR. C. W. DURHAM, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
*Rock Island, Ill., March 1, 1893.*

MAJOR: I have the honor to submit the following report of operations for the improvement of the Mississippi River in the division under my charge, extending from Minneapolis, Minn., to the vicinity of Keithsburg, Ill., for the calendar year ending December 31, 1892:

### MINNEAPOLIS TO ST. PAUL.

This work was carried on during the season with a special allotment of $50,000, in act of September 19, 1890, and under project approved February 28, 1891. The work projected consists in protecting caving banks, building dams of brush, rock, and gravel, dredging gravel bars and removing rocks and bowlders from channel, Channels of varying widths and of 3 feet in depth at low water were dredged through the bars at Pike Island, below Fort Snelling Bridge; at Fisherman Island, and below Franklin Avenue Bridge. The dredged material in great part was used in construction of dams for closing side chutes and contracting water way, and in reinforcing shore protections. The removal of rocks from the channel between the Minneapolis landing and Meekers Island was carried on by means of steam drill and derrick boats. The channel for a width of about 100 feet, has been cleared of all projecting rocks in the stretch of river above referred to.

Operations between Minneapolis and St. Paul, as also those between St. Paul and Lake Pepin, were in local charge of Mr. J. D. DuShane, superintendent, whose report is given below nearly in full:

"The river and harbor act of September 19, 1890, provided that of the sum appropriated for improving the Mississippi River from Minneapolis to the Des Moines Rapids, '$50,000 shall be expended between the Chicago, St Paul, Minneapolis and Omaha Railroad Bridge, at St. Paul, and the Washington Avenue Bridge, Minneapolis, in dredging, removal of gravel, bowlders, and broken rock, and the construction of dams and revetments.'

"Work similar to that of 1891 has been continued during the season of 1892, under project approved February 28, 1891. This project provides that 'the work shall be carried on by days' labor and use of Government plant; by purchase of materials in open market at prices fixed by competition, and by hire of dredges from private parties after due competition, provided Government dredges be not available,' and contemplates the removal of gravel, bowlders, and broken rock, and the construction of dams and bank revetments, so as to form an open river channel. Where rock removal or dredging is necessary, it is proposed to secure a channel 200 feet wide and 3 feet deep at low water of 1864; this will provide, at ordinary low stages, a navigable depth of 4 feet or more."

"*Dredging.*—Operations were resumed May 27, 1892. Advantage was taken of the high stage of water at this time to make the cuts through the gravel bars in the vicinity of Pike Island, below Fort Snelling, which could be dredged to advantage only at high water, as at low stages no dumping grounds were available. The high water also facilitated building dams and bank revetments with the materials dredged from the gravel bars. The first work undertaken was the widening of the unfinished cut through the bar opposite the upper end of the revetment of the left bank. The channel through the bar was widened from 40 feet, as left at the close of the season of 1891, to 100 feet. Dredging at this bar was suspended June 11, but owing to a considerable fill having occurred in the left part of the channel, the dredge was put at work again on August 13, widening the channel on the right side. Eight cuts were made through this bar during 1892, leaving a clean channel 500 feet long and 100 feet wide. This bar is composed of sand, and gravel of one-half inch, and less, diameter, with much mill refuse collected in piles 20 to 40 feet across and several feet in depth. The dredged material weighed from 104 to 118 pounds per cubic foot. Of the material dredged from this bar—14,032.8 cubic yards—a part was dumped from scows on line of dams 1 and 2 (sheet C), but owing to its light weight and the small size of the gravel it will not remain long in position against the action of the strong current in this part of the river.

"A channel, 1,500 feet long and 125 feet wide, was dredged through the bar below the Fort Snelling Bridge. The material composing this bar is sand and gravel in nearly equal parts, with some mill refuse in small piles scattered through the bar. This material weighed from 98 to 125 pounds per cubic foot. The heaviest and coarsest material was found at the upper end of the bar, and the lightest at the lower end, where it was mostly sand, with a small percentage of sawdust; the gravel varied in size, the largest being about 10 cubic inches. Of 30,846.7 cubic yards of material removed from this bar, about 14,000 cubic yards were used in the construction of dams and bank revetments in the immediate vicinity.

"At Randolph street, below Groveland Park, a channel about 300 feet long and 100 feet wide was dredged. The material—5,122.2 cubic yards, weighing from 117 to 125 pounds per cubic foot—taken from this cut, consisted of sand, coarse gravel, shell rock, and bowlders less than 1 foot in diameter, and was wasted in the slough back of Fishermans Island.

"Below the Franklin Avenue Bridge, at the foot of the rapids, the dredge made four cuts, varying in length from 300 to 500 feet, opening a channel 70 feet wide and 3 feet below low water. The material here consisted of coarse gravel, and bowlders and ledge rocks from 1 to 20 cubic feet in size. The material dredged from this bar—2,554.8 cubic yards, estimated to weigh 125 pounds per cubic foot—was wasted near the right bank below the Shortline Bridge. Near the upper end of this cut the dredging went down to the underlying soft sand rock, about 1 foot below grade, or about 4 feet below low water of 1864.

"Dredging operations were suspended October 8. The total quantity dredged during 1892 is 52,556.5 cubic yards, of which 19,253.4 cubic yards were used in building dams and revetments and 33,303.1 cubic yards were wasted.

"*Dams and revetments.*—During the progress of dredging operations, the construction of dams and revetments was carried on. The material used in these works was a part of that dredged for making channels through the gravel bars below the Fort Snelling Bridge, and was all deposited in place from dump scows. These works were thus obtained without cost to the Government, for had they not been made the material used in their construction—19,253.4 cubic yards—would have been wasted.

"Dams 1 and 3 (sheet C*) are closing dams from the left bank; dams 4 and 5 (sheet C) are wing dams from the left bank; dams 2, 6, and 7 (sheet C) are wing dams from the right bank (Pike Island); dams 4 and 5 (sheet C) are practically finished. Dams 1, 2, 3, 6. and 7 (sheet C) are low and unfinished, it being impracticable to complete them, owing to the lower stage of water which existed during the latter part of the dredging operations in this vicinity.

"A bank revetment 1,000 feet long, midway between the head and foot of Pike Island, was made by depositing gravel on the natural slope of the bank from dump scows when the water surface was at or near the top of the bank. A part of this gravel will remain, but much of it will be washed away from year to year by the action of the rapid current during high water.

"*Removing rocks and bowlders.*—This work was resumed August 27, and continued until November 4, when operations were suspended on account of cold weather. With the view of opening the channel to the steamboat landing on the east bank at Minneapolis, operations were confined principally to removing the largest and most dangerous rocks from the channel limits above the point to which work had been carried last year (1891).

A number of rocks were also removed by derrick boat from the dredged cut below the Franklin Avenue Bridge, these rocks being more quickly and cheaply handled by derrick than by dredge.

There were removed from the channel limits 2,945 pieces of rocks, containing 976 solid cubic yards; rocks less than 1 foot in diameter were not enumerated. Five hundred and fifteen pounds of dynamite were used in blasting 136 rocks, in which 152 holes of an aggregate depth of 297 feet were drilled by the steam drill. With the exception of a small number, the rocks removed from the channel were dumped in the slough back of Meekers Island.

During 1893 work should be continued, removing bowlders and rocks from the channel on the rapids and from the pool above the rapids; the dredged cut below the Franklin Avenue Bridge should be extended. Dredging will be necessary at and below the Minneapolis Landing, west bank, in order to make this landing accessible for steamboats during low stages of water.

*Financial statements for works of improving the Mississippi River between Minneapolis and St. Paul during the season of 1892.*

| | |
|---|---|
| Amount expended in the field during the calendar year (exclusive of $1,329.77 liabilities outstanding December 31, 1891) | $15,687.31 |
| Add quota of general superintendence and office expenses (exclusive of $4.25 liabilities outstanding December 31, 1891) | 1,337.07 |
| Add for use and deterioration of plant | 692.12 |
| Total | 17,716.50 |

The following statements show the cost of the different classes of works accomplished:

*Removing bowlders.*

| | |
|---|---|
| Amount expended in the field during the calendar year | $5,594.98 |
| Add quota of general superintendence and office expenses | 419.30 |
| Add for use and deterioration of plant | 692.12 |
| Total | 6,706.40 |
| Bowlders removed (solid cubic yards) | 976 |
| Average cost per cubic yard for field work | $5.733 |
| Average cost per cubic yard for general superintendence and office expenses | .430 |
| Average cost per cubic yard for plant | .709 |
| Average cost per cubic yard of bowlders removed | 6.872 |

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*Sheet letters are those of Major Allen's survey of 1887.

*Dredging gravel bars.*

| | |
|---|---|
| Amount paid contractor | $9,589.33 |
| Add cost of local inspection | 503.00 |
| Add quota of general superintendence and office expenses | 753.90 |
| Total cost of dredging | 10,846.23 |
| Material dredged ... cubic yards | 52,556.5 |
| Average cost per cubic yard dredged | $0.192 |

The work between Minneapolis and St. Paul was in local charge of H. E. Clark, overseer, whom I take pleasure in commending.

### ST. PAUL TO LAKE PEPIN.

In this section of river work was continued on the same general plan as in former years and as shown in the report of Superintendent J. D. DuShane:

Under projects approved February 28, 1891, and August 9, 1892, work was continued between St. Paul and Lake Pepin by days' labor and use of Government plant, the materials being secured by days' labor, by purchase in open market, and by formal contract.

Work was resumed August 5, 1892, at Island 18, where 500 feet of shore protection was added to that commenced in 1891.

August 8th the fleet was moved up the river and work on dams in the vicinity of Red Rock and Newport was commenced. Dams 39, 40, 41, 42, 43, 44 (sheet 2[*]), and 26, 27, 28, 29, and 30 (sheet 3) were built; Dams 17, 18, 24, 25 (sheet 2), and 1 (sheet 3) were raised; Dams 21, 22, 23, 26, 27, 28 (sheet 2), and 15, 17, 18, 19 (sheet 3) were raised and extended, and the shore protection of right bank opposite Island 3 was repaired.

Work in this vicinity was suspended October 10, and the following day the fleet moved to Red Wing. The shore protection of left bank above Red Wing, built in 1880, was repaired, carried to the top of the bank, and extended at both ends. The extension on the upper end is 1,080 feet long, and has an average width of 77 feet. The lower extension is 728 feet long, averaging 56 feet wide, and the average width of bank protected back of the old protection is 43 feet. The top of the old protection was originally 6 feet above low water, the top of the protection is now at the top of the bank, about 12 feet above low water, for the entire length of 3,938 feet. The right bank above Red Wing was protected for a distance of 2,800 feet from the mouth of the bay, the protection of an average width of 35 feet being carried to the top of the bank. A revetment, 700 feet long and 35 feet wide, extending to the top of the bank, was put on the narrow strip of bank of Island 24, between the river and Upper Lake. It was hoped that the entire length of this narrow strip of land could be protected before the close of navigation, but the work had to be suspended before completion on account of cold weather.

A part of the plant was taken to Wharf Boat Bar November 8, and on suspension of the work at Red Wing November 12 the rest of the fleet was moved to that point, where Dam 13 (sheet 8) was built below Dam 11, and Dam 14 (sheet 8) was begun below Dam 13; these are both wing-dams from the right bank, in continuation of the series begun during 1891.

Slight repairs were made to the shore protection (sheet 5) below Nininger Light.

Operations for the season closed November 14, and the fleet, excepting towboat *Fury* and Barge 100 was laid up in the winter harbor at Boulanger Slough; the *Fury* and Barge 100 were laid up at South Stillwater for repairs.

The prices paid for materials delivered on United States barges were as follows: In open market, prices being fixed by competition, rock, per cubic yard, 42, 44, and 49 cents; brush, per cubic yard, 28, 28⅞, and 29 cents; poles, 2⅛ and 3 cents each. By formal contract, rock, 62 cents per cubic yard. The materials furnished by days' labor, including cost of outfit, tools, subsistence, blasting materials and lathyarn, cost 95 cents per cubic yard for rock, and 41 cents per cubic yard for brush. The outfit and tools are still on hand, available for future work.

There were 2,003.5 cubic yards of brush left on hand at the close of the season, which has been stored at Boulanger Slough, opposite Nininger, and at Sturgeon Slough.

Works of improvement should be constructed during the season of 1893 at the following places: A dam above Dam 13 (sheet 2), dams in the vicinity of Grey Cloud Landing, dams above and below Hastings, dams below Prescott, extension of the series of dams at Island 21; the revetments opposite Island 1, below Newport, below Pine Bend, at head of Island 18, opposite Hastings, below Island 19, and below Red Wing, should be extended, and new revetments should be built below Smiths Bar, below Morgans Bar, below Sturgeon Slough, opposite Island 23, and below Red Wing; repairs should be made to dams at Island 1, and to the shore protection above and dams opposite Robinsons Rocks.

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[*] Sheet numbers are those of the general maps, survey of 1878-1879.

*List of works constructed and repaired and of materials used during the season of 1892 between St. Paul and Lake Pepin.*

| Designation. | Dimensions. |  | Material. |  |
|---|---|---|---|---|
|  | Length. | Height above low water of 1864. | Rock. | Brush. |
| Sheet 2: | *Feet.* | *Feet.* | *Cub. yds.* | *Cub. yds.* |
| Dam 39 | 120 | 4.5 | 179.9 | 591.1 |
| Dam 40 | 490 | 4.5 | 753.5 | 2,279.5 |
| Dam 41 | 275 | 4.5 | 244.9 | 555.9 |
| Dam 42 | 185 | 4.5 | 163.8 | 636.2 |
| Dam 43 | 85 | 4.5 | 135.9 | 481.4 |
| Dam 44 | 140 | 4.5 | 289.4 | 390.5 |
| Dam 17, raised | ........ | ........ | 181.4 | ........ |
| Dam 18, raised | ........ | ........ | 88 | ........ |
| Dam 21, raised and extended | 45 | 4.5 | 665.1 | 970.9 |
| Dam 22, raised and extended | 105 | 4.5 | 574 | 995.5 |
| Dam 23, raised and extended | 65 | 4.5 | 468.6 | 707.9 |
| Dam 24, raised | ........ | 4 | 102 | ........ |
| Dam 25, raised | 40 | 4 | 137.5 | 249.7 |
| Dam 26, raised and extended | 55 | 4 | 361.5 | 620.7 |
| Dam 27, raised and extended | 70 | 4 | 364.7 | 1,085.7 |
| Dam 28, raised and extended | 26 | 4.5 | 161.6 | 268.4 |
| Revetment opposite Island 3, repaired | ........ | ........ | 127 | ........ |
| Sheet 3: |  |  |  |  |
| Dam 26 | 180 | 4.5 | 294.6 | 835.9 |
| Dam 27 | 180 | 4.5 | 207.6 | 470.1 |
| Dam 28 | 320 | 4.5 | 318.2 | 813.9 |
| Dam 29 | 255 | 4.5 | 398.6 | 803.2 |
| Dam 30 | 175 | 4.5 | 196.4 | 507.4 |
| Dam 1, raised | ........ | 4 | 168.3 | 399.2 |
| Dam 15, raised and extended | ........ | 4 | 218.8 | 227.3 |
| Dam 17, raised and extended | 85 | 4 | 276.7 | 617.5 |
| Dam 18, raised and extended | 70 | 4 | 260.8 | 582.8 |
| Dam 19, raised and extended | 95 | 4.5 | 377.3 | 1,017.7 |
| Dam 20, raised and extended | 35 | 4 | 178.5 | 417 |
| Sheet 5: |  |  |  |  |
| Revetment, Island 16, finished | 500 | ........ | 366.3 | 68.4 |
| Sheet 6: |  |  |  |  |
| Revetment, opposite Nininger, repaired | ........ | ........ | 223.9 | ........ |
| Sheet 8: |  |  |  |  |
| Dam 13 | 450 | 4 | 601.6 | 1,606.5 |
| Dam 14, partly built | ........ | ........ | 433.7 | 1,326.8 |
| Sheet 10: |  |  |  |  |
| Revetment, above Red Wing, repaired and extended | 1,808 | ........ | 4,480 | 2,018.2 |
| Revetment, right bank, above Red Wing | 2,800 | ........ | 4,129.7 | 2,037.8 |
| Revetment, left bank, above Red Wing | 700 | ........ | 712.9 | 738 |
|  | ........ | ........ | 18,842.7 | 24,332.1 |
| Add for poles put in works | ........ | ........ | ........ | 366.5 |
| Materials put in works | ........ | ........ | 18,842.7 | 24,698.6 |

*Financial statement for works of improving Mississippi River between St. Paul and Lake Pepin during the season of 1892.*

DAMS AND REVETMENTS.

| | |
|---|---|
| Amount expended in the field during the calendar year 1892, including $1,057.62 liabilities outstanding December 31, 1892 (from distribution sheets) | $36,879.67 |
| Add retained percentage on contracts | 113.56 |
| Add cost of materials from 1891 | 393.28 |
|  | 37,386.51 |
| Deduct for material on hand at close of season | 814.22 |
| Net cost of field work | 36,572.29 |
| Add quota of general superintendence and office expenses | 2,091.04 |
| Add for use and deterioration of plant | 3,175.48 |
| Total cost of work | 41,838.81 |

Material put in works:

| | | |
|---|---|---|
| Rock | cubic yards.. | 18,842.7 |
| Brush | do.... | 24,698.6 |
| Total | do.... | 43,541.3 |

| | |
|---|---|
| Average cost per cubic yard on barges | $0.495 |
| Average cost per cubic yard for towing and putting in material | .345 |
| Average cost per cubic yard for general superintendence and office expenses | .048 |
| Average cost per cubic yard for plant | .073 |
| Average cost per cubic yard in place | .961 |

REPAIRS TO PIER AT LAKE CITY HARBOR OF REFUGE ON LAKE PEPIN.

This pier was built in 1887, is 871 feet in length, of which 512 feet is crib work, and the remainder earthen embankment, with a covering of rock about 18 inches thick. At the time of construction, in order to lessen the cost, the water being from 20 to 28 feet deep at low stage for most of the length of the pier, a foundation of gravel was put in with material dredged from bars in vicinity of Lake City. By this means the depth of the lake on the line of the pier was reduced to about 5 feet at low water.

The crib work, having been damaged somewhat by ice, was repaired in 1890.

An examination made by me in September, 1892, showed that the crib had settled about 0.5 foot at the outer end and 0.1 foot at the shore end since completion. Quite extensive repairs were made in 1892, the details of which are given in the following extracts from the report of Mr. W. A. Thompson, superintendent in local charge:

"During the breaking up of the ice in the spring of 1892 a few of the timbers in the crib work were broken and many of the plank loosened and a few broken.

"The gravel embankment under the crib work has during the last five years been gradually sliding out from under the cribs, and thereby endangering the stability of the upper structure.

"There was available at the beginning of the calendar year 1892 of the appropriation of July 5, 1884, for improving Mississippi River from St. Paul to the Des Moines Rapids—applied to Lake City, Minn.—the sum of $1,645.83, and the river and harbor act of July 13, 1892, under item of improving Mississippi River from the mouth of the Missouri to Minneapolis, further provides for the repairs of the harbors of refuge on Lake Pepin.

"Authority for the repairs was obtained October 17, 1892.

"It was necessary to delay the needed repairs to this pier until low water permitted a thorough examination, and owing to such necessary delay work was not commenced until the latter part of October.

"The carpenter work was performed by days' labor and purchase of material (lumber, spikes, etc.) in open market. The brush and rock work was performed by Jacob Richtman at his contract prices for similar work between Reeds Landing and Minneiska. The broken timbers were removed and new ones of the same dimensions (6 inches by 12 inches, 16 feet) were put in their places. Such plank as were not badly broken were respiked to the timbers. All the missing oak plank were replaced by pine plank, it being impossible to get oak for the purpose. A timber (6 inches by 12 inches, 16 feet), was spiked to the bottom course of timbers on top of the planking to serve as a clamp and to prevent the ice in the future from tearing the plank loose. The carpenter work was finished November 14.

"By the gravel sliding out from under the cribs quite a large quantity of the rock had dropped down out of the cribs. Mr. Richtman refilled the cribs with rock. The work of preventing further sliding of the gravel from under the cribs was commenced November 2 and completed November 21. This work consisted of riprapping the embankment on the south side and outer end with a course of brush 12 to 20 feet long, as the necessity required, and about 15 inches thick, laid perpendicular to the line of pier, with the butts of the brush against the crib work. On top of the brush was placed a layer of rock from 1 to 1¼ feet thick.

"The amount of material used in the work was: Rock, 846 cubic yards; brush, 315 cubic yards."

*Financial statement for repairs to Lake City pier in 1892.*

| | |
|---|---|
| Amount paid for rock and brush in place, including $481.91 outstanding December 31, 1892 | $1,464.48 |
| Carpenter work, lumber, spikes, etc | 1,083.02 |
| Cost of local inspection, etc | 133.03 |
| Add quota of general superintendence and office expenses | 31.34 |
| Total | 2,711.87 |

### REEDS LANDING TO MINNEISKA.

Work in this locality, consisting of the construction and repair of brush and rock dams and shore protections, was carried on, at first by agreement with Jacob Richtman, in accordance with approved project of January 6, 1891, and later by contract with Mr. Richtman, under approved project of August 9, 1892, and allotment of $45,000 from appropriation of July 13, 1892. The prices paid *under agreement* for material in place were: Rock, $1.20, and brush, 27 cents per cubic yard; under contract: Rock, $1.53, and brush, 54 cents per cubic yard. This increase in cost (41 per cent) is doubtless due in great part to the recent eight-hour law. The prices paid Mr. Richtman under agreement were the same as those paid him under his 1891 contract.

Details of the work are shown in the following extracts from the report of Mr. W. A. Thompson, superintendent in local charge:

"*Work done under agreement.*—Owing to high water, work under the informal agreement was not commenced until August 5, and was completed October 22, 1892.

"All the work done was in the vicinity of Pine Island, about 3 miles below Alma, Wis. The head of Pine Island was protected, and the closing dam from the east side of Pine Island to west side of Island 41 was commenced, but owing to the low water and the trouble in getting the boats and barges near the dam, work was temporarily suspended August 18, and the work of protecting the shore at Pine Island Bend on Island 42 was commenced. This bank was very difficult to protect, as for a long distance the water close to the bank was from 15 to 20 feet deep.

*List of works constructed and repaired and of materials used between Reeds and Minneiska during season of 1892 under informal agreement.*

| Designation. | Length. | Material. | |
|---|---|---|---|
| | | Rock. | Brush. |
| **Sheet 15:** | *Feet.* | *Cub. yds.* | *Cub. yds.* |
| Shore protection, Pine Island | 300 | 552.2 | 594.8 |
| Closing Dam 14, begun | | 246.4 | 356.8 |
| Shore protection, Island 42 | 5,350 | 8,923.8 | 8,319.3 |
| Shore protection, Island 42, repaired | | 397.0 | 150.0 |
| Materials put in works | | 10,119.4 | 9,420.9 |

*Financial statement for work between Reeds and Minneiska performed under agreement during season of 1892.*

| | | |
|---|---|---|
| Amount paid Jacob Richtman | | $14,686.93 |
| Cost of local inspection, etc | | 445.46 |
| Add quota of general superintendence and office expenses | | 741.96 |
| Total | | 15,874.35 |
| **Material put in works:** | | |
| Rock | cubic yards | 10,119.4 |
| Brush | do | 9,420.9 |
| Total | | 19,540.3 |
| Average cost per cubic yard in place | | $0.812 |

"*Contract.*—The work done under the contract was in vicinity of Pine Island and below Alma, Wis. It was commenced October 24. The work of protecting the shore of Pine Island Bend was completed October 31. The total length of shore protected on Island 42, in Pine Island Bend, is 7,910 feet, including 900 feet built in 1887, 920 feet in 1891, and 6,090 feet in 1892. Of the latter, 740 feet were built by Mr. Richtman under his contract of August 9, 1892.

"The work of protecting the west side of Island 41 was commenced October 31. This shore protection begins at the log slide of the Alma sawmill, about 250 feet below the head of the island, and extends downstream a distance of 2,300 feet.

"On November 21 the boats and barges were taken into winter quarters, and work was temporarily suspended.

"Mr. Richtman was granted authority to complete the closing dam east of Pine Island and such other dams as were to be built on dry bars and in very shoal water during the winter, the material to be hauled to the dams by teams.

"On November 29 work was resumed on the closing dam, and it was completed December 28, and the construction of Dam 15 (sheet 15), 800 feet above the closing dam, was commenced. At the close of the year this dam was not completed.

*List of works constructed and of materials used during season of 1892, under contract with Jacob Richtman, between Reeds Landing and Minneiska.*

| Designation. | Dimensions. | | Material. | |
|---|---|---|---|---|
| | Length. | Height above low water of 1864. | Rock. | Brush. |
| Sheet 15: | *Feet.* | *Feet.* | *Cub. yds.* | *Cub. yds.* |
| Shore protection, Island 42 | 740 | .......... | 1,172.2 | 829.6 |
| Shore protection, Island 41 | 2,300 | .......... | 3,739.5 | 3,424.4 |
| Closing Dam 14 | 875 | 4.5 | 1,005.6 | 1,040.1 |
| Dam 15, begun | .......... | .......... | 332.7 | 471.1 |
| Total | .......... | .......... | 6,255.0 | 5,765.2 |

*Financial statement for work between Reeds and Minneiska, performed under contract during season of 1892.*

| | |
|---|---|
| Amount paid contractor (including $9,367.52 outstanding December 31, 1892) | $11,415.04 |
| Retained percentage | 1,268.33 |
| Cost of local inspection, etc | 443.55 |
| Add quota of general superintendence and office expenses | 643.62 |
| Total | 13,770.54 |

| | | |
|---|---|---|
| Material put in works: | | |
| Rock | cubic yards | 6,255.0 |
| Brush | do | 5,765.2 |
| Total | do | 12,020.2 |
| Average cost per cubic yard in place | | $1.146 |

MINNEISKA TO LA CROSSE.

The improvement of this stretch of river, 52 miles in length, by construction of dams and shore protections, was carried on under project approved February 28, 1891, and also under project approved August 9, 1892, and allotment of $45,000 from the appropriation of July 13, 1892. Work during the season of 1892 was performed by hired labor and use of Government plant, the towboat *Alert* and launches *Ada* and *Elsie* being used for towing. The greater part of the material was purchased in open market, at 40 cents per cubic yard for sand rock, 50 cents for lime rock, and 22 cents for brush, loaded on United States barges. Nearly all of the rock used was a soft sand rock, which, if carefully handled, forms a good substitute for the harder lime rock heretofore chiefly used, and costs about one-third less. It hardens under water and on exposure to air, as is shown by experience in the use of it in former years.

The United States cut and loaded on barges 13,923.8 cubic yards of brush by days' labor, at an average cost of 21.4 cents per cubic yard.

Contracts have been let for 5,000 cubic yards sand rock at 50 cents per cubic yard, 30,000 cubic yards at 53 cents, and for 40,000 cubic yards brush at 30¼ cents, for use in above-mentioned work. The increase in cost of material, doubtless due in great part to the recent eight-hour law; averages 31¼ per cent for rock and 38¾ per cent for brush.

The following extract comprises the greater part of the report of Mr. W. A. Thompson, superintendent in local charge of operations:

"The first work was done in the vicinity of Queens Bluff, where the steamboat channel had been obstructed by sand at an 8-foot stage of water. This sand had been driven down the river from the bars in the vicinity of Richmond Island, about 2 miles above. The width of the river in the vicinity of Richmond Island had been contracted about one-half in 1891 by the closing dam across Richmond Chute and the wing dams from the Wisconsin shore opposite Richmond Island, consequently a very large quantity of sand in this contracted channel was forced by the increased velocity of the current down the river and deposited at the first wide part of the river reached, which was about one mile below Queens Bluff.

"To get this large quantity of sand permanently out of the way, six new wing dams were built (see map of survey made in 1892), two above old wing dams from the Minnesota shore, two from the west side of Island 89, and two from the Wisconsin shore below Island 89. The old wing dams (Nos. 1 and 2, sheet 20) were raised to 4 feet above low water, and No. 1 was extended 100 feet and No. 2 150 feet.

"The average height of the new dams is about 3 feet above low water. As the water was at about a 5-foot stage when the dams were built, a large part of the sand in the channel was carried over and deposited below the dams or forced still further down the river and deposited in the deep holes below.

"Since the completion of the above work, navigators have had but little trouble in this part of the river even after it had fallen to a 2 foot stage.

"The work of protecting the head and 600 feet of the upper west side of Island 93 was completed August 31.

"The river between Dresbach Island and La Crescent, a distance of about 2¼ miles, has, for many years, been difficult to navigate. Nothing heretofore has been done to improve navigation in this part of the river. In some places it was a half mile wide and divided into two channels—one very shoal and the other narrow, crooked, and deep at low stages of water. There were stretches where the water in the channel was from 20 to 35 feet deep and others where it was only 3 or 4 feet deep at low water. From experience we know the best way to improve such a river is to build low dams in the deep places—that is, dams with the crown within about 5 or 6 feet of low-water surface, and where the channel is wide and shoal to build high dams—to contract and deepen the channel. The sand that is driven down the river will to a great extent be deposited around the low dams and can cause no further trouble.

"The work of building these dams was commenced August 23 and continued until November 15, the close of navigation. The location of these dams are shown on the map of the survey of this part of the river made in 1892.

"There were 31 wing dams, 1 closing dam, and 900 feet of shore protection on head of Island 98, built between Dresbach Island and La Crescent. Their dimensions are given in the following table under sheet 21.

"There were left on hand at close of season 4,049.6 cubic yards of brush, which was unloaded and piled up on Barrons Island."

*List of works constructed and repaired, and of materials used, during the season of 1892, between Minneiska and La Crosse.*

| Designation. | Dimensions. | | Material. | |
|---|---|---|---|---|
| | Length. | Height referred to low water of 1864. | Rock. | Brush. |
| | *Feet.* | *Feet.* | *Cub. yds.* | *Cub. yds.* |
| Sheet 17: | | | | |
| Closing dam 20, repaired | ........ | ............ | 151.9 | ........ |
| Sheet 19: | | | | |
| Wing dam 17 | 550 | +3 | 580.4 | 1,534.1 |
| Wing dam 18 | 340 | +3 | 482.2 | 904.5 |
| Closing dam 8, repaired | ........ | +4 | 96.9 | ........ |
| Sheet 20: | | | | |
| Wing dam 9 | 500 | +3 | 667.3 | 2,216.8 |
| Wing dam 10 | 250 | +4 | 359.8 | 611.6 |
| Wing dam 11 | 725 | +3 to —6 | 1,071.2 | 1,120.2 |
| Wing dam 12 | 565 | +3 to —6 | 480 2 | 1,083.8 |
| Wing dam 1, raised and repaired | ........ | +4 | 1,351.7 | 1,235.6 |
| Wing dam 2 raised and repaired | ........ | +4 | 1,504.2 | 1,922.4 |
| Sheet 21: | | | | |
| Shore protection, Island 93 | 800 | ............ | 1,353.9 | 739.6 |
| Wing dam 9 | 500 | —4 | 548.1 | 2,536.6 |
| Wing dam 10 | 400 | —5 | 663.5 | 1,460.0 |
| Shore protection, Island 98 | 900 | ............ | 1,559.6 | 669.4 |
| Wing dam 11 | 190 | —6 | 462.9 | 884.4 |
| Wing dam 12 | 365 | —4 | 880.2 | 1,550.6 |
| Wing dam 13 | 630 | +4 to —4 | 432.8 | 1,290.1 |
| Wing dam 14 | 325 | —4 | 450.3 | 608.2 |
| Wing dam 15 | 380 | +4 to —4 | 310.6 | 227.9 |
| Wing dam 16 | 525 | +4 | 933.7 | 2,227.5 |
| Closing dam 17 | 600 | +4 | 1,474.6 | 2,410.4 |
| Wing dam 18 | 675 | +4 | 893.6 | 2,504.7 |
| Wing dam 19 | 225 | +4 to —4.5 | 215.4 | 222.6 |
| Wing dam 20 | 875 | +4 | 1,222.9 | 1,750.4 |
| Wing dam 21 | 290 | —5.5 | 498.4 | 945.2 |
| Wing dam 22 | 875 | +4 | 743.7 | 2,055.4 |
| Wing dam 23 | 317 | +4 | 470.6 | 1,548.0 |
| Wing dam 24 | 360 | +4 | 452.7 | 1,348.1 |
| Wing dam 25 | 250 | +4 | 172.4 | 340.6 |
| Wing dam 26 | 310 | +3 to —5 | 228.3 | 645.0 |
| Wing dam 27 | 110 | +4 to —4 | 75.0 | 232.2 |
| Wing dam 28 | 140 | +4 to —6 | 331.8 | 1,040.7 |
| Wing dam 29 | 815 | +4 to —7 | 328.8 | 950.4 |
| Wing dam 30 | 175 | +4 to —6 | 86.2 | 564.2 |
| Wing dam 31 | 523 | +4 | 913.4 | 3,844.4 |
| Wing dam 32 | 330 | +4 to —7 | 299.3 | 1,055.2 |
| Wing dam 33 | 300 | +4 | 666.8 | 2,497.4 |
| Wing dam 34 | 700 | +4 | 658.1 | 1,185.7 |
| Wing dam 35 | 850 | +4 to —3 | 888.0 | 3,155.1 |
| Wing dam 36 | 625 | +4 | 399.4 | 1,438.6 |
| Wing dam 37 | 600 | +4 | 651.6 | 1,218.3 |
| Wing dam 38 | 760 | +4 | 405.0 | 795.1 |
| Wing dam 39 | 820 | +4 | 406.1 | 1,359.8 |
| Wing dam 40 | 400 | +4 | 518.1 | 1,065.5 |
| Total amount of materials | ........ | ............ | 27,351.1 | 57,235.5 |

*Financial statement for work between Minneiska and La Crosse, performed by hired labor during season of 1892.*

| | |
|---|---|
| Amount expended in the field during the calendar year 1892, including $2,491.18 liabilities outstanding December, 31, 1892 (from distribution sheets) | $47,517.25 |
| Deduct cost of material on hand at close of season | 890.91 |
| Net cost of field work | 46,626.34 |
| Add quota of general superintendence and office expenses | 2,710.59 |
| Add for use and deterioration of plant | 4,352.04 |
| Total cost of work | 53,688.97 |
| Material put in works: | |
| Rock ...cubic yards | 27,351.1 |
| Brush ...do | 57,235.5 |
| Total ...do | 84,586.6 |

| | |
|---|---|
| Average cost per cubic yard on barges | $0.277 |
| Average cost per cubic yard for towing and putting in material | .274 |
| Average cost per cubic yard for general superintendence and office expenses | .032 |
| Average cost per cubic yard for plant | .051 |
| Average cost per cubic yard in place | .634 |

### GENOA TO PRAIRIE DU CHIEN.

Under project approved August 9, 1892, and allotment of $50,000, contract, dated October 11, 1892, was entered into with A. Kirchner, for the construction of brush and rock dams and shore protections, at $1.40 per cubic yard for rock in place, and 66 cents for brush in place.

No work was done in this locality during the season.

### GLENHAVEN TO DUBUQUE.

Under project approved August 9, 1892, and allotment of $50,000, contract, dated October 3, 1892, was entered into with A. J. Whitney for the construction of brush and rock dams and shore protections, at $1.40 per cubic yard for rock in place, and 59 cents per cubic yard for brush in place.

No work was done in this locality during the season.

### BELLEVUE TO SAVANNA.

Under project approved January 6, 1891, and allotment of $25,000, contract dated March 2, 1891, was entered into with Patterson Brothers for the construction of brush and rock dams, at 90 cents per cubic yard for rock in place, and 38 cents per cubic yard for brush in place. No work was done in this locality during the season of 1891, and the time for completion of the contract was extended to November 15, 1892. Operations were commenced May 9, 1892 and continued until May 20, when on account of high water work was temporarily suspended until July 25. From this date work was carried on until October 19, when the contract was completed. The first work accomplished was the construction of a closing dam (1, sheet 40) at Apple River Chute (Island 57) which was followed by the closing of the cut-off in Island 357 (Dam 2, sheet 40).

The object of the above work was the contraction of the waterway, with a view to the improvement of the Sand Prairie and Arnolds Crossings, both bad obstructions for many years. The plant was then moved to Santa Fe, at which locality the following improvements were made: Shore protection on Towhead opposite Island 263; Dam 4 (sheet 4) running from Iowa shore to Towhead; Dam 5, closing Sabula Slough; wing dams 6 and 7, extending from Iowa shore, and some repairs to Dam 3, running out from Island 262.

The object of the above works is to improve and straighten the channel at Santa Fe Bar, and their beneficial effect was felt before the end of the season. This contract closed with small amount of work on dam to close cut-off at Island 265.

Mr. A. J. Stibolt was the inspector in local charge of the work.

*A list of works constructed and repaired and of materials used during the season of 1892 between Bellevue and Savanna.*

| Designation. | Dimensions. | | Material. | |
|---|---|---|---|---|
| | Length. | Height above low water of 1864. | Rock. | Brush. |
| **Sheet 40:** | *Feet.* | *Feet.* | *Cub. yds.* | *Cub. yds.* |
| Dam 1 | 700 | 4 | 2,280.4 | 1,788.5 |
| Dam 2 | 100 | 5 | 585.7 | 328.5 |
| **Sheet 41:** | | | | |
| Shore protection on Towhead | 1,750 | | 2,174.9 | 1,352.5 |
| Dam 3, repaired | | 4 | 713.1 | 458.5 |
| Dam 4 | 850 | 4 | 2,049.1 | 1,942.0 |
| Dam 5 | 240 | 5 | 863.1 | 740.4 |
| Dam 6 | 525 | 4 | 1,883.8 | 2,502.5 |
| Dam 7 | 710 | 4 | 1,755.3 | 1,884.2 |
| Dam 8, commenced | | | 139.6 | 276.5 |
| Total materials put in works | | | 12,445.0 | 11,273.6 |

*Financial statement for work between Bellevue and Savanna, performed under contract, during season of 1892.*

| | |
|---|---|
| Amount paid contractor | $15, 484. 47 |
| Cost of local inspection, etc | 1, 239. 22 |
| Add quota of general superintendence and office expenses | 947. 19 |
| Total | 17, 670. 88 |
| Material put in works: | |
| Rock ........ cubic yards.. | 12, 445. 0 |
| Brush ........ do.... | 11, 273. 6 |
| Total ........ do.... | 23, 718. 6 |
| Average cost per cubic yard in place | $0. 746 |

## DUBUQUE TO CLINTON.

Under project approved August 9, 1892, and allotment of $50,000, contract, dated October 8, 1892, was entered into with Patterson Brothers for the construction of brush and rock dams and shore protection at $1.40 per cubic yard for rock in place and 59 cents per cubic yard for brush in place.

Operations under this contract were commenced October 20, and ended for the season November 12, 1892. Mr. A. J. Stibolt was the inspector in local charge. The work accomplished consisted in the construction of 1,310 lineal feet of shore protection on Island 265, Dam 8 (sheet 41), closing gap in Island 265, shore protection Island 266, and repairs to Dam 2.

*A list of works constructed and repaired and of materials used during the season of 1892 between Dubuque and Clinton.*

| Designation. | Dimensions. | | Material. | |
|---|---|---|---|---|
| | Length. | Height above low water of 1864. | Rock. | Brush. |
| Sheet 41: | *Feet.* | *Feet.* | *Cub. yds.* | *Cub. yds.* |
| Dam 8 | 197 | 5 | 874. 7 | 555. 8 |
| Dam 2, repaired | ........ | ........ | 61. 9 | ........ |
| Shore protection, Island 265 | 1, 310 | ........ | 1, 363. 8 | 1, 251. 8 |
| Shore proctection, Island 266 | 350 | ........ | 446. 2 | 380. 8 |
| Total materials put in works | ........ | ........ | 2, 746. 6 | 2, 188. 4 |

*Financial statement for work between Dubuque and Clinton performed under contract during season of 1892.*

| | |
|---|---|
| Amount paid contractor | $4, 622. 76 |
| Cost of local inspection, etc | 271. 87 |
| Add quota of general superintendence and office expenses | 277. 46 |
| Add retained percentage on contract | 513. 64 |
| Total | 5, 685. 73 |
| Material put in works: | |
| Rock ........ cubic yards.. | 2, 746. 6 |
| Brush ........ do.... | 2, 188. 4 |
| Total ........ do.... | 4, 935. 0 |
| Average cost per cubic yard in place | $1. 152 |

NOTE.—The increase in cost per cubic yard (55 per cent) of the work "between Dubuque and Clinton" over that performed by the same contractors "between Bellevue and Savanna," was chiefly due to the provisions of the eight-hour law.

## IMPROVING ROCK ISLAND RAPIDS.

This work was in local charge of Mr. J. C. McElherne, superintendent. On account of high water, operations with drill boat did not commence until August 8, from which date until November 17 she was employed at Winnebago and Moline chains. Dredge *Ajax* began work on the rapids on August 25, and remained there until November 9, during which time she completed the removal of the broken rock at Winnebago Chain and the greater part of that at Moline Chain. She also furnished considerable additional rock for use in construction of dams by dredging from the pool below Duck Creek Chain and from the chain itself. She further removed the wreck of the *Silas Wright* and a large quantity of debris from the Moline Water Power Pool. But little work was done in the construction of dams during the season, and this work was limited to the strengthening of dams 3, 8, 8½, and 10. Some needed repairs to Guide Piers 1½, 4, 5, 6, 7, 8, 10, and 12, were made.

The following extracts are taken from Mr. McElherne's report:

"*Rock excavation.*—On August 8, 1892, drill boat 103 was set at work on upper end of shoulder at head of Winnebago Chain, at the point she discontinued her labors in the fall of 1891. The remainder of this obstruction having been effectually disrupted, as proposed, the boat was moved down river August 22, and taken to the remaining unfinished north half of channel at lower end of Moline Chain. A section 100 feet wide and 500 feet long (afterwards extended 400 feet) was first outlined with long, stout, flexible range poles, and the drill boat was then put at work on the downstream southwest corner. The rock patches met with were not numerous, but of large area, and varied from a few tenths to 2 or 3 feet above grade.

"From the outset headway was retarded to a considerable extent by occasional accidents, the extreme hardness of the material, the existence of sand and gravel, and the velocity of the current, but the principal trouble experienced, and the one that occasioned the most delay, was the frequent interruptions caused by passing rafts, which compelled the drill boat in every instance to move completely beyond the channel limits. As a partial offset to these obstacles, and in order to accomplish as much work in the meantime as was practicable, it was decided to increase the number of the crew, as also the number of hours of daily service, and therefore a double crew was put on—one for duty from 3 a. m. to 12 m.; and the other from 12:30 p. m. to 9 p. m., permitting 8 hours of actual work per day for each shift. This arrangement proved very successful, and very much increased the amount of work accomplished. Furthermore, the early and late parts of each day afforded an excellent opportunity to work, being free from any interference by rafts or tows. Work was carried on here in the usual manner—by crossing the lay-out with successive ranges 56 feet in width, from the center of the channel to the north edge of the defined cut. In this way an area 90 feet wide and 868 feet long was carefully blasted over, but the upstream limit of the high patches was not quite reached at the end of the season.

"Dredge *Ajax* arrived on August 25, and was set at work in the pool between foot of Duck Creek Chain and the Iowa shore. This place had been used in former years as a dumping ground, but at the request of the pilots it was dredged out, in order to make it more available as a landing for rafts, and as a harbor for boats during storms. The material dredged from this pool was used in the construction of dams.

"From August 31 to September 10 work was carried on by the dredge upon the middle and lower half of Duck Creek Chain, for the purpose of removing such loose material as could not be reached in the fall of 1891, when the water was extremely low. There then being urgent need of speedily removing the broken rock at the head of Winnebago Chain, the dredge was sent there, and succeeded in thoroughly completing this task in thirteen days' time, after which she removed the wreck of the *Silas Wright* from the Illinois edge of the channel, below Buoy 17½. She then returned to Duck Creek Pool and Chain on September 27, and dredged out all the material that could be obtained from the former, and whatever loose rock and bowlders that could be found by diligent search in the latter.

"On October 10 the dredge was moved to the head of Moline Water Power Pool, where a few days were spent in removing portions of cribs and cofferdam material, which had been left there in the spring of 1891, and which proved to be serious obstructions to boats and rafts going to Moline. After accomplishing this task the dredge was placed at lower end of Moline Chain, where in following up the drill boat she made very satisfactory headway. In addition to the material prepared for her by blasting, a large quantity of bowlders and large, flat rocks were taken out. Before overtaking the drillboat, however, she was towed away from the Rapids on November 9, and taken to winter quarters at Keokuk, Iowa.

"*Dams.*—Owing to the impossibility of procuring rock in quantities as desired until late in the fall, but little headway was made in the way of construction. A few small lots, however, were secured from the adjacent shores, and these, together with the output from the dredge and that which was finally received under formal contract, were used where most needed. The foundation of Dam 3 (sheet 47) was lengthened, and also raised 3 or 4 feet above the bottom in an irregular flat ridge for a distance of about 300 feet. Dam 8 was leveled up and given a covering of spalls to make it passable as a roadway during the winter months. When the water had fallen sufficiently to oblige the raftboats to keep their tows within the channel at Winnebago Chain, there was great danger of their being carried by the side draft out over the Illinois edge of the channel and on to the rocky reefs below the island. To prevent such an occurrence, a trailing dam, No. 8½, to extend down river from the foot of Winnebago Island, was commenced, the dimensions as built being: height, 5 feet above low water of 1864; width, 6 feet; length, 850 feet. As work progressed on this dam it became very apparent that it was producing the desired effect, which gave satisfaction to a large number of river men. Dam 10, extending from the Iowa shore below Duck Creek to a shoal reef near the channel (where the building of guide pier No. 20 is contemplated), about 150 feet above the lower end of the chain, received some attention, but, beyond putting in a few loads of material near the shore end, little was done there, for the reason that the material procured was in urgent demand elsewhere.

"The dam extending down stream from foot of Benhams Island was lengthened about 300 feet, with the debris dredged from Moline Chain.

"*Guide Piers.*—Such guide piers as had sustained injury from the action of the ice and high water were repaired as circumstances permitted. The section of slope wall on north side of No. 5, which was found to have been undermined, was rebuilt in cement. Nos. 1½, 4, 5, 6, 7, 8, 10, and 12 received each a sufficient quantity of riprap rock to replace that which had been carried away from their foundations.

"*In general.*—All the rock obtained from quarries in the immediate vicinity went to dams 3 and 10, and that obtained from Le Claire to dams 8 and 8½ and the guide piers. The material dredged at Winnebago and Duck Creek Chains was used sparingly in No. 10, but very largely in building up No. 8½, while that from Moline Chain was placed in Benhams Island dam. The material taken from Moline Pool being entirely useless for building purposes, it was wasted in the eddy outside of the Government dike.

"For towing in connection with the different parts of the work, the steam launch *Louise* was found to be equal to all requirements.

"On November 17 a blustering snowstorm set in, and, as winter seemed to be at hand, all work was closed, and the drillboat, as also her attendant quarterboats, etc., were securely laid up for the winter in Moline Pool, and put in charge of a watchman.

*Details of operations.*

| | |
|---|---|
| Launch *Louise*: | |
| Hours working | 874 |
| Miles run | 2,524 |
| Drillboat No. 103: | |
| Hours working | 1,085 |
| Hours lost, owing to rafts | 132 |
| Hours lost, owing to accidents | 17 |
| Hours lost, owing to storms | 25 |
| Number of holes drilled | 1,973 |
| Number of holes blasted | 1,827 |
| Linear feet of holes drilled | 5,224 |
| Range poles set in rock | 150 |
| Number of solid cubic yards of rock blasted | 2,137 |
| Number of pounds of dynamite used | 3,973 |
| Dredge *Ajax*: | |
| Hours working | 568 |
| Hours lost, owing to rafts | 58 |
| Hours lost, owing to accidents | 28 |
| Hours lost, owing to storms | 0 |
| Number of solid cubic yards of rock dredged and removed | 3,075 |
| Number of cubic yards, loose rock, and bowlders dredged and removed | 1,665 |
| Number of cubic yards sand, mud, etc., dredged and removed | 2,000 |
| Number of wrecks removed | *1 |

---

* *Silas Wright.*

*Cost of rock excavation, including charge for use and deterioration of plant.*

| Locality. | Rock excavated (solid cubic yards). | Total cost. | Average cost per solid cubic yard. |
|---|---|---|---|
| Winnebago Chain, removed | 455.5 | .......... | .......... |
| Moline Chain, removed | 1,535.0 | .......... | .......... |
| Total | 1,990.5 | $9,415.07 | $4.73 |
| Moline Chain, blasted only | 146.8 | 452.14 | 3.08 |
| Total | 2,137.3 | 9,867.21 | .......... |

*Cost of dredging sand and mud, etc., including charge for use and deterioration of plant.*

| Locality. | Cubic yards. | Cost. | Average cost per cubic yard. |
|---|---|---|---|
| Moline Pool | 2,000 | $326.61 | $0.16⅓ |

*Cost of repairs to piers, including charge for use and deterioration of plant.*

| Material. | Cubic yards. | Cost. | Average cost per cubic yard. |
|---|---|---|---|
| Slope-wall stone | 17.8 | $81.88 | $4.60 |
| Riprap stone | 599.1 | 617.07 | 1.03 |
| Total | 616.9 | 698.95 | .......... |

*Cost of work on dams, including charge for use and deterioration of plant.*

| Designation. | Total length. | Cubic yards. |
|---|---|---|
| Sheet 47: | *Feet.* | |
| Dam 3, wing, lengthened 300 feet | 300 | 611.8 |
| Dam 8, closing, slightly repaired | .......... | 139.7 |
| Dam 8¼, trailing, new | 850 | 3,368.0 |
| Dam 10, wing, partly built | .......... | 507.8 |
| Dam at foot of Benhams Island, trailing | 300 | 1,535.0 |
| Total | .......... | 6,162.3 |

| | |
|---|---|
| Cost of dams | $6,347.17 |
| Cubic yards of material put in | 6,162.3 |
| Average cost per cubic yard in place | $1.03 |

*Financial statement for improvement of Rock Island Rapids for season of 1892.*

| | |
|---|---|
| Amount expended in field during calendar year 1892 (from distribution sheets) | $14,573.13 |
| Add quota of general superintendence and office expenses | 826.29 |
| Add for use and deterioration of plant | 1,840.52 |
| Total | 17,239.94 |
| Distributed as follows: | |
| 1. Rock excavated and removed | $9,415.07 |
| 2. Rock broken up, but not removed | 452.14 |
| 3. Repairs to old piers | 698.95 |
| 4. Dams 3, 8, 8¼, 10, and Benhams Island | 6,347.17 |
| 5. Sand, mud, etc., removed from old cofferdam | 326.61 |
| | 17,239.94 |

### BUOYS ON ROCK ISLAND RAPIDS.

The buoys, having been repaired and repainted, were reset April 5 to 12, by steam launch *Louise*. There are now thirty buoys in the system. All the range stakes were carefully examined and repaired.

During the high water of spring and summer, many of the buoys were carried away by rafts, and these to the number of fifteen were reset.

On November 9 and 10 the buoys were taken up and stored for the winter. The cost of buoyage for the season of 1892 was $398.66.

### REMOVING BOWLDERS BELOW KEITHSBURG.

From October 26 to November 5 the snag boat *J. G. Parke* and dredge *Phœnix* were employed in removing clay and bowlders from the channel crossing below Keithsburg. The cost of this work was $1,002.84.

### SURVEYS AND GAUGES.

Examinations and surveys were made at different times and at various localities along the river bank, with a view to future work or for ascertaining the results of work already accomplished. The localities at which surveys were made are as follows: In the vicinity of Grey Cloud Landing; below Prescott, at Lake City Pier; below Alma, Minneiska to Chimney Rock; Richmond to Lacrosse; vicinity of Queens Bluff, Lacrosse to Brownsville; below Genoa; Bad Axe Bend, Iowa Slough, De Soto to Heytmans; Gordons Bay to Prairie le Sioux; Eagle Point; Four Mile Island; Santa Fe and Sand Prairie to Arnolds. Numerous connections were made with the precise levels of the Mississippi River Commission. Gauges were kept at Hastings, Redwing, Winona, and North McGregor during the year. Gauge records were also obtained from the Signal Service and bridgekeepers at St. Paul, Rock Island, Keokuk, Burlington, Quincy, Hannibal, and Louisana.

Amount expended on surveys and gauges, above Keokuk, during the calendar year was $3,468.35.

### PURCHASE, CONSTRUCTION, REPAIR, AND CARE OF PLANT.

During the year, under project approved August 9, 1892, and special authorities of July 29, August 10 and 30, September 9, 10, and 16, considerable additions and repairs to plant were made. There were purchased 10 barges (100 by 20), at $825 each; 3 barges (100 by 20), at $806 each; 1 barge (82 by 18), at $560; 3 barges (50 by 12), at $275 each; 1 launch, *Edith* (naphtha), at $850; 1 launch, *Florence* (oil), at $450, and 7 small quarter boats. There were rebuilt 4 quarter boats, 1 pile-driver, and 1 drill boat. Extensive repairs were made to towboats *Fury*, *Vixen*, *Alert*, and *Coal Bluff*; to launches *Lucia*, *Emily*, and *Iris*, and to 6 barges, and 3 dumps. Nominal repairs were made to towboat *Success*, launches *Elsie* and *Ada*, 40 barges, and 5 dumps.

The following table gives, by calendar years, from 1887 to 1892, inclusive, the quantities of material (rock and brush) put in the various works of improvement between St. Paul and Des Moines Rapids, the cost of same, including general superintendence and office expenses, use and deterioration of plant, and the average cost per cubic yard in place:

| Year. | Materials (rock and brush.) | Total cost of materials in place. | Average cost per cubic yard in place. |
|---|---|---|---|
| | *Cubic yards.* | | |
| 1892 | 237,316.4 | $188,218.07 | $0.793 |
| 1891 | 307,332.8 | 232,460.39 | .756 |
| 1890 | 78,125.8 | 76,429.78 | .978 |
| 1889 | 540,509.7 | 431,124.58 | .798 |
| 1888 | 48,243.4 | 61,067.00 | .959 |
| 1887 | 224,756.7 | 209,721.29 | .933 |
| Grand total | 1,436,284.8 | 1,199,041.11 | .835 |

NOTE.—From commencement of improvement in 1878 to December 31, 1892, there were constructed, between St. Paul and mouth of Illinois River, 348,107 linear feet (66 miles) of dams and 366,091 linear feet (70 miles) of shore protections, consuming 2,511,473 cubic yards of material.

Very respectfully, your obedient servant,

C. W. DURHAM,
*Assistant Engineer.*

Maj. A. MACKENZIE,
*Corps of Engineers, U. S. Army.*

### REPORT OF MR. M. MEIGS, UNITED STATES CIVIL ENGINEER.

UNITED STATES ENGINEER OFFICE,
*Keokuk, Iowa, February 9, 1893.*

MAJOR: I have the honor to submit the following report of operations for work done under my direction between Keithsburg, Ill., and Montrose, Iowa, during the calendar year ending December 31, 1892. The work was in charge of Supt. S. Edwards, whose report is given below nearly in full.

### KEITHSBURG TO MONTROSE.

This work was carried on by days' labor and use of Government plant, the towboat *Vixen* and the launch *Lucia* being used as towboats. The work was begun May 2, with launch *Lucia*, but on account of the sudden high water was discontinued May 7, part of fleet being laid up at Dallas City and part returned to Des Moines Rapids Canal and the force discharged. August 2, the river having receded, I resumed work with the *Vixen* as towboat, and the *Lucia* was started out August 8. The boats towed for different gangs, employed at different points on the river. Work was carried on near Keithsburg, Ill.; at Benton Island; near Burlington, Iowa; Dallas City, Pontoosuc, and Nauvoo, Ill.

The *Vixen* was employed towing for the Keithsburg, Benton Island, Burlington, Dallas, and Nauvoo works, running day and night.

The launch *Lucia* was employed at Pontoosuc until October 13, working single crew, when she was returned to the Des Moines Rapids Canal, the *Vixen* being able to do the towing for both gangs.

*Vicinity of Keithsburg.*—Work at this point was carried on from August 2 to September 21, and consisted in building Dam 13 (Sheet 55), from foot of Keithsburg Island, length 1,100 feet; laying apron for Dam 14 (Sheet 55), same to be completed at some future time, and to be built of piling and brush; in slight repairs to Dam 18 (Sheet 55); in building 2,112 linear feet of shore protection on the Illinois shore above Keithsburg Bridge, and in extending shore protection on Huron Island, 640 feet downstream.

Though the above work will do much to improve this locality, which for years has been troublesome, a number of dams should be built on the Iowa side of the channel, to complete and make permanent the improvements.

The United States snag boat *J. G. Parke*, with dredge *Phœnix*, worked for a few days in this vicinity, removing obstructing bowlders and clay. The cost of the work done by the *Parke* and dredge was $1,002.84.

*Material used, vicinity of Keithsburg.*

| Designation. | Rock. | Brush. | Poles. | Total. |
|---|---|---|---|---|
| | *Cub. yds.* | *Cub. yds.* | *Cub. yds.* | *Cub. yds.* |
| Dam 13 | 3,454.4 | 3,237 | 193.1 | 6,884.5 |
| Dam 14 | 596.2 | 1,302 | 10 | 1,908.2 |
| Dam 16 | 92.4 | 70 | .......... | 162.4 |
| Shore protection above Keithsburg bridge | 2,024.3 | 2,191 | 52.5 | 4,267.8 |
| Shore protection on Huron Island | 545.8 | 481 | 16.5 | 1,043.3 |
| Total | 6,713.1 | 7,281.0 | 272.1 | 14,266.2 |

*Benton Island.*—For a number of years boats, and especially rafts, have experienced great difficulty in passing the head of this island, due to the draft of water into Benton Slough and the narrowness of the channel. Rafts without a bow boat were often compelled to run out lines to bar above, to prevent their striking the island,—this precaution not always being successful. Even with a bow boat, rafts have come to grief here.

The success of this improvement was noticeable even before the dam was completed, and boats and rafts passed without any trouble or delay for the remainder of the season.

*Material used at Benton Island.*

| | Rock. | Brush. | Poles. | Total. |
|---|---|---|---|---|
| | *Cub. yds.* | *Cub. yds.* | *Cub. yds.* | *Cub. yds.* |
| Shore protection | 1,243.5 | 797 | 32.2 | 2,072.7 |
| Dam 1 | 1,206.2 | 1,577 | 82.6 | 2,865.8 |
| Total | 2,449.7 | 2,374 | 114.8 | 4,938.5 |

Work at Benton Island was carried on from September 19 to October 7, 1892.

*Vicinity of Burlington.*—Part of the force worked here from November 1 to November 5, repairing shore protection on Illinois side above Burlington. The repairs consisted in recovering the bank at various points where the rock had been removed, probably by ice.

*Material used, vicinity of Burlington.*

| | | |
|---|---|---|
| Rock | cubic yards.. | 285.8 |

*Vicinity of Dallas.*—The improvements at this point were carried on from October 3 to close of season, and consisted in building 5,089 linear feet of shore protection on Thompsons Island (No. 384), and in building Dam 4 (Sheet 60).

Owing to the shortness of the remaining season it was not practicable to protect the whole length of the island, and the work was directed towards protecting the bends. The bank was a very high one, and necessitated a long wheel. The whole length of the shore should be protected as soon as practicable.

Dam 4 (Sheet 60) is a brush and pile dam, 660 feet long, and shuts off a great deal of water formerly lost to the regular channel. It connects the large sand bar above head of Dallas Chute and Grape Island.

*Material used, vicinity of Dallas.*

| | Rock. | Brush. | Poles. | Total. | Piling. |
|---|---|---|---|---|---|
| | *Cub. yds.* | *Cub. yds.* | *Cub. yds.* | *Cub. yds.* | *Lin. feet.* |
| Dam 4 | 451 | 1,974 | 7 | 2,432 | 3,663 |
| Shore protection, Thompsons Island | 5,780.6 | 6,116 | 188.5 | 12,085.1 | .......... |
| Total | 6,231.6 | 8,090 | 195.5 | 14,517.1 | 3,663 |

Dam 4 (sheet 60) should be extended toward the Illinois side of the river, on south side of sand bar, and a few more dams built on the same side, to better improve this place, which for a couple of years, during low water, has been one of the bad places in this division.

*Vicinity of Pontoosuc.*—The work at this point was carried on between August 8 and October 7, and consisted in repairing Dam 16 (sheet 60), raising and repairing Dam 13, and in building Dam 14. Dam 13 was built during season of 1889, to a height of 3 feet above low water, but had settled down to about low water, and was raised to 4 feet. Its length is 2,240 feet. Work on Dam 14 was begun in 1889 and resumed in 1890, but both years discontinued owing to low water. It was this year completed, and built to 4 feet above low water. Its length is 2,240 feet. The series of dams built at this point during the last four years have done good work and materially improved this part of the river. To continue improvement, these dams should all be raised to at least 5 or 6 feet above low water, either with rock and brush, or with piling and brush, and the outer edges of the bars should be protected. The towing of material for Pontoosuc works was done entirely by launch *Lucia*, and was in local charge of Mr. John Carpenter from August 8 to September 1, and Mr. Byron Layton from September 1 to October 7.

*Material used, vicinity of Pontoosuo.*

| | Rock. | Brush. | Poles. | Total. | Piling. |
|---|---|---|---|---|---|
| | *Cub. yds.* | *Cub. yds.* | *Cub. yds.* | *Cub. yds.* | *Lin. feet.* |
| Dam 13 | 1,576.6 | 2,336.7 | 155.4 | 4,068.7 | .......... |
| Dam 14 | 2,900.4 | 4,217.9 | 189.4 | 7,307.7 | .......... |
| Dam 16 | .......... | .......... | .......... | .......... | 904 |
| Total | 4,476 | 6,554.6 | 344.8 | 11,376.4 | 904 |

*Vicinity of Nauvoo.*—The work consisted in protecting Island 394 and sand bar formed at lower end by building 1,572 lineal feet of shore protection. Owing to the bad weather this work was not completed at the time of closing the season's work.

*Material used, vicinity of Nauvoo.*

| | Rock. | Brush. | Poles. | Total. |
|---|---|---|---|---|
| | *Cub. yds.* | *Cub. yds.* | *Cub. yds.* | *Cub. yds.* |
| Shore protection, Island 394 | 1,661.6 | 1,875 | 53.8 | 3,590.4 |

*In general.*—The high water during May, June, and July not only shortened the season considerably, but made it difficult during August to get brush in sufficient quantities, owing to the soft condition of the lowlands. This necessitated using a greater amount of rock and consequently increased the cost of work per cubic yard.

"The long tow at Keithsburg, in several instances (108 miles to the round trip), also increased the cost, for the reason that a very large force could not be employed, as the amount of material that could be towed was limited. None of the above-mentioned improvements can be considered complete, and work can be carried on advantageously next season at the same points.

Dam 4 (sheet 60) was built of piling and brush, and, being the first one of this kind on this division, a description of the manner in which it was built is submitted. With a quick-working pile-driver these dams can be built in a very short time, and I am of the opinion that for many places they are an improvement on rock and brush dams. I consider it perfectly practicable to build these dams at a higher stage than under the old method, and thus, as it were, create a longer season of operations. Through these dams doing their work at high water, sand bars would be formed high enough to be easily protected at a low stage. A number of these dams could be built at Keithsburg, Burlington, and above Dallas. In fact, most of the dams proposed to be built near Burlington should, in my opinion, be of this kind, the location being favorable for them.

*Description of pile and brush dams.*—An apron is laid, piling is driven with 4 feet space between, and cap placed on piling. The building barge is dropped down broadside against piling, and the brush is laid on the building barge, extending over the piling 4 feet and bound to cap with binding poles fastened down with heavy fence wire. The building barge is then moved upstream from under the brush, and the latter allowed to drop into the river, leaving the brush almost perpendicular, according to the depth of the water.

The prices paid for material on United States barges ranged from 40 to 78 cents per cubic yard for rock, and 20 to 30 cents per cubic yard for brush. At the close of the season there remained on hand 817.8 cubic yards of rock, valued at $327.12.

*List of works constructed and repaired, and of material used, during the season of 1892, between Keithsburg and Montrose.*

| Destination. | Dimensions. | | Material. | | | |
|---|---|---|---|---|---|---|
| | Length. | Height above low water, 1864. | Rock. | Brush. | Poles. | Piling. |
| | *Feet.* | *Feet.* | *Cub. yds.* | *Cub. yds.* | *Number.* | *Lin. feet.* |
| Sheet 55: | | | | | | |
| Dam 13 | 1,100 | 4 | 3,454.4 | 3,237 | 1,931 | .......... |
| Dam 14, apron | .......... | .......... | 596.2 | 1,302 | 100 | .......... |
| Dam 18, repaired | .......... | .......... | 92.4 | 70 | .......... | .......... |
| Revetment above Keithsburg Bridge | 2,112 | .......... | 2,024.3 | 2,191 | 525 | .......... |
| Revetment on Huron Island | 640 | .......... | 545.8 | 481 | 165 | .......... |
| Sheet 56: | | | | | | |
| Dam 1 | 568 | 4 | 1,206.2 | 1,577 | 826 | .......... |
| Revetment, Benton Island | 870 | .......... | 1,243.5 | 797 | 322 | .......... |
| Sheet 58: | | | | | | |
| Revetment above Burlington, repaired | .......... | .......... | 285.8 | .......... | .......... | .......... |
| Dam 4 | 660 | 7 | 451 | 1,974 | 70 | 3,663 |
| Dam 13, rebuilt | .......... | .......... | 1,576.6 | 2,336.7 | 1,554 | .......... |
| Dam 14 | 2,240 | 4 | 2,900.4 | 4,217.9 | 1,894 | .......... |
| Dam 16, repaired | .......... | .......... | .......... | .......... | .......... | 904 |
| Revetment, Island 384 | 5,089 | .......... | 5,780.6 | 6,116 | 1,885 | .......... |
| Sheet 62: | | | | | | |
| Revetment, Island 394 | 1,572 | .......... | 1,661.6 | 1,875 | 538 | .......... |
| Materials put in works | .......... | .......... | 21,818.8 | 26,174.6 | 9,810 | 4,567 |

*Financial statement for works of improvement between Keithsburg and Montrose during season of 1892.*

| | |
|---|---|
| Amount expended in field during the calendar year 1892 (from distribution sheets) | $30,739.31 |
| Add cost of material on hand January 1, 1892 | 3,800.98 |
| Add retained percentage January 1, 1893 | 242.84 |
| | 34,783.13 |
| Deduct cost of material on hand January 1, 1893 | 327.12 |
| Net cost of field work | 34,456.01 |
| Add quota of general superintendence and office | 1,742.70 |
| Add for use and deterioration of plant | 3,490.08 |
| Total cost | 39,688.79 |
| Material put in works: | |
| Rock ... cubic yards | 21,818.8 |
| Brush ... do | 26,174.6 |
| Poles ... do | 981.0 |
| Total ... do | 48,974.4 |
| Average cost per cubic yard on barges | $0.416 |
| Average cost per cubic yard for towing and putting in material | .288 |
| Average cost per cubic yard for general superintendence and office expenses | .036 |
| Average cost per cubic yard for plant | .071 |
| Average cost per cubic yard in place | .811 |

M. MEIGS,
*United States Civil Engineer.*

Maj. A. MACKENZIE,
*Corps of Engineers, U. S. A.*

### REPORT OF MR. M. MEIGS, U. S. CIVIL ENGINEER.

UNITED STATES ENGINEER OFFICE,
*Keokuk, Iowa, February 21, 1893.*

MAJOR: I have the honor to submit the following report of work in my charge between Des Moines Rapids and the mouth of the Illinois River for the calendar year ending December 31, 1892. Mr. A. L. Richards, superintendent, was in local charge of a large part of the work.

#### KEOKUK TO HANNIBAL.

The snagboat *J. G. Parke* and barges were started out April 19, 1892, under charge of Mr. A. L. Richards, but the early advent of extreme high water caused a suspension of the work May 8. This high water occurring during the best part of the working season, caused a serious loss of time to the working force, and very greatly restricted the operations for the year.

Repairs were made to Dams 2, 3, 5, and 7 (sheet 66), between Canton and La Grange, the rock being taken from La Grange and Quincy, and cut by days' labor. The high stage of water and the muddy state of the ground made the cost of brush rather high—about 26½ cents per cubic yard.

In the vicinity of Des Moines River work was begun August 27 with the *Parke* and barges, under charge of Mr. A. L. Richards, superintendent, and continued later by Mr. J. C. Kille, overseer, with the towboat *Success*, dredge *Phœnix* and pile-driver 104.

The plant used by Mr. Kille was of a nondescript character, and mostly improvised for temporary use, consisting of 6 dump boats decked over and converted into rock barges, and a few worn out flatboats. This work was, therefore, considerably handicapped.

Two dams (4 and 5, sheet 63) were built of piles, brush, and rock, and dredged material; one from the Illinois shore and one from the Iowa shore, to remove an extremely shoal crossing which had given great trouble to boats during the season of 1891.

As the work progressed, material improvement was apparent, the channel being both straightened and deepened. The two surveys at this point show clearly the changes that occurred.

On October 12 the working force was removed to Hannibal. At this point a serious undermining of the Illinois shore, one-half mile above Hannibal, had occurred and necessitated extensive works of bank protection. The bank averaged in height 16 feet above low water and was very ragged and abrupt and a great deal of heavy snagging was necessary. The head of Turtle Island was also protected.

*A list of works constructed and repaired, and of materials used during season of 1892, between Keokuk and Hannibal.*

| Designation. | Dimensions. | | Material. | | | |
|---|---|---|---|---|---|---|
| | Length. | Height above low water of 1864. | Gravel. | Piling. | Rock. | Brush. |
| Sheet 63: | *Feet.* | *Feet.* | *Cub. yds.* | *Lin. ft.* | *Cub. yds.* | *Cub. yds.* |
| Dam 4, wing | 820 | 6 | 2,378.1 | 2,326 | 2,573.6 | 4,045.4 |
| Dam 5, wing | 800 | 4 | 1,846.8 | 1,316 | 1,525.4 | 2,611.8 |
| Sheet 66: | | | | | | |
| Dam 2, repaired | ........ | 6 | ........ | ........ | 756 | 406.9 |
| Dam 3, repaired | ........ | 4 | ........ | ........ | 1,608.4 | 444.6 |
| Dam 5, repaired | ........ | 5 | ........ | ........ | 1,337.9 | 500 |
| Dam 7, repaired | ........ | 5 | ........ | ........ | 2,644.5 | 1,415.4 |
| Sheet 70: | | | | | | |
| Shore protection, Turtle Island | 2,640 | ........ | ........ | ........ | 262 | 498 |
| Shore protection, left bank above Hannibal bridge | 818 | ........ | ........ | ........ | 1,944.1 | 3,624 |
| Materials put in works | ........ | ........ | ........ | ........ | 12,651.9 | 13,541.1 |

*Financial statement for work between Keokuk and Hannibal, performed by hired labor during the season of 1892.*

| | |
|---|---|
| Amount expended in the field during the calendar year 1892 (from distribution sheets) | $24,618.59 |
| Deduct cost of material on hand at close of season (271 cubic yards brush) | 71.00 |
| | 24,547.59 |
| Add retained percentage on contracts for rock and brush | 273.88 |
| Add quota of general superintendence and office expenses | 1,886.96 |
| Add for use and deterioration of plant | 2,463.25 |
| Total | 29,171.68 |
| Material put in works— | |
| Rock ... cubic yards | 12,651.9 |
| Brush ... do | 13,541.1 |
| Total ... do | 26,193.0 |
| Average cost per cubic yard on barges | $0.448 |
| Average cost per cubic yard for towing and putting in material | .500 |
| Average cost per cubic yard for general superintendence and office expenses | .072 |
| Average cost per cubic yard for plant | .094 |
| Average cost per cubic yard in place | 1.114 |

NOTE.—If gravel is included as material, the cost per cubic yard is $0.959.

### HANNIBAL TO ILLINOIS RIVER.

At Hickory Chute, as the water attained a low stage, the difficulty of last season was repeated. An immense mass of sand continued to pass down and through the foot of the chute, making it the most difficult point for steamers between St. Louis and St. Paul. A crooked channel was discovered through the lower dam of 1891, by which for a time boats were able to pass the obstructions lodged in the main channel, but this finally became too crooked for navigation and had to be abandoned.

Under Mr. A. L. Richards' supervision an extension of the towhead downstream was built, and the lower dam on the Missouri side, No. 4 (sheet 74) was raised and strengthened. These two works so contracted the channel that in the course of the winter a radical improvement is to be expected, but much more work will probably be necessary before this obstruction is removed. On November 18 the force was withdrawn, to go into winter quarters.

The vicinity of Reds Landing presented a number of shoal places, the principal difficulty appearing opposite a house in the center of the field above Reds. On this crossing the water got as low as 3½ feet to 4 feet, but no boats were detained there for any length of time.

Two dams were built out from the Illinois shore, to straighten the bend and push the channel towards the center of the river. It also became necessary, after the dams had been finished, to protect the shore below on the Illinois side. The surveys show a great receding of the Illinois bank of the river in this vicinity, amounting in places to 300 feet in the last fifteen years.

The whole stretch of river, from Hamburg to the foot of Westport Island, is very shoal, and needs extensive works of improvement.

Great delay was experienced in getting rock from the contractors on this portion of the river, and work progressed here, as well as at Hickory Chute, very slowly in consequence. Low water had considerable to do with it, but with the ordinary methods of hauling by team and loading with wheelbarrows, it seemed impossible to get more than 150 cubic yards per day at any one landing.

It seems more and more apparent that, with the delivery of rock restricted to one or two places of loading, the work of delivering rock must be handled by modern methods and the use of machinery whenever possible in order to attain good results.

*A list of works constructed and repaired and of materials used during the season of 1892 between Hannibal and the Illinois River.*

| Designation. | Dimensions. | | Material. | | |
|---|---|---|---|---|---|
| | Length. | Height above low water of 1864. | Piling. | Rock. | Brush. |
| | *Feet.* | *Feet.* | *Lin. ft.* | *Cub. yds.* | *Cub. yds.* |
| Sheet 74: | | | | | |
| Dam 4, repaired | | 6 | | 1,680.4 | 2,345.9 |
| Dam 5, longitudinal | 1,350 | 3 | 116 | 1,183.6 | 4,013.4 |
| Dam 6, wing, pile | 440 | 6 | 898 | | |
| Sheet 79: | | | | | |
| Dam 9, wing | 480 | 6 | | 1,953.3 | 1,880.6 |
| Dam 11, wing | 475 | 6 | | 1,295.3 | 1,741.7 |
| Shore protection, Reds Landing | 1,400 | | | 2,242.3 | 381.3 |
| Materials put in works | | | | 8,354.8 | 10,362.9 |

*Financial statement for work between Hannibal and the mouth of the Illinois River, performed by hired labor during season of 1892.*

| | |
|---|---|
| Amount expended in the field during the calendar year 1892 (from distribution sheets) | $15,973.65 |
| Deduct cost of piling in longitudinal dam | 268.66 |
| | 15,704.99 |
| Add retained percentage on contracts for rock and brush | 742.41 |
| Add quota of general superintendence and office expenses | 1,179.68 |
| Add for use and deterioration of plant | 1,966.03 |
| Total | 19,593.11 |
| Material put in works: | |
| Rock, cubic yards | 8,354.8 |
| Brush, do | 10,362.9 |
| Total | 18,717.7 |
| Average cost per cubic yard on barges | $0.457 |
| Average cost per cubic yard towing and putting in material | .440 |
| Average cost per cubic yard general superintendence and office expenses | .063 |
| Average cost per cubic yard for plant | .105 |
| Average cost per cubic yard in place | 1.065 |

### SURVEYS.

| | Miles. |
|---|---|
| 1. Under the direction of Mr. S. Edwards, superintendent, assisted by Mr. A. L. Richards, a survey was made from the mouth of Bloody Run, at Keokuk, Iowa, to Alexandria, Mo., between April 1 and 16, using the launch *Lucia* | 3 |
| 2. Another survey was made of the above-mentioned locality by Mr. W. E. Gordon, surveyor, September 1 to 16, to show the progress of the work of improvement | 3 |
| 3. Whitneys Bar was surveyed by Mr. Gordon, using the launch *Stella* and quarterboat No. 121, between November 7 and 10 | 4 |
| 4. Vicinity Reds Landing. Survey made by Mr. Gordon and party, September 17 to October 1 | 6 |
| 5. Vicinity of Cap au Gris, by same party, October 29 to November 3 | 4 |
| 6. Vicinity Piasa Island, by same party, between October 10 and October 27 | 7 |

Mr. Gordon's party was engaged on these surveys between September 1 and November 10, when the boat went into winter quarters in the canal. The maps of these surveys are nearly completed at the present writing, and will be submitted shortly.

The cost of surveys between Keokuk and Illinois River amounted to $2,741.92.

### REPAIRS TO PLANT.

Considerable repairs were made to many pieces belonging to this part of the river. Pieces repaired are as follows: Towboats *Success* and *Coal Bluff*, dredge *Vulcan*, launch *Iris*, quarterboats 56, 59, 55, 46, and 121, barges 62, 88, 48, 50, 51, 155, 156, 157, 158, and 53, dumps 8 and 10, pile-driver 58, grasshoppers 139, 140, 141, and 142.

The cost of repairs, including care of plant, was $9,596.17.

Very respectfully, your obedient servant,

M. MEIGS,
*United States Civil Engineer.*

Maj. A. MACKENZIE,
*Corps of Engineers, U. S. A.*

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### REPORT OF MR. C. W. DURHAM, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
*Rock Island, Ill., July 1, 1893.*

MAJOR: I have the honor to present a brief preliminary report of operations between Missouri River and Minneapolis during the second half of the fiscal year ending June 30, 1893, as collated from reports of assistant engineers and superintendents in local charge. Full reports are made by calendar years.

*Minneapolis to St. Paul.*—In local charge of Supt. J. D. DuShane. No work has been done in 1893 to June 30. It is proposed to make a survey at an early day, with the view of preparing exact estimates of costs of locks and dams.

*St. Paul to Lake Pepin.*—An allotment of $65,000 has been made for this work from the appropriation of March 3, 1893. The work is in local charge of Supt. J. D. DuShane. The United States plant to be used in this work has been put in good order.

On account of high water preventing advantageous work, operations were not resumed in this part of the river until the last week of the fiscal year.

*Smiths Bar to Lake Pepin.*—In local charge of Supt. J. D. DuShane. Under allotment of $50,000 from appropriation of March 3, 1893, it is proposed to protect cutting banks in this section of the river, the work to be done by formal contract. Project and specifications have been made and approved. Proposals have been invited and will be opened July 6, 1893.

*Reeds Landing to Minneiska.*—In local charge of Supt. W. A. Thompson. Operations in the construction of dams and shore protections have been carried on from January 1 to June 30, 1893, under formal contract with Jacob Richtman, of Fountain City, Wis. Progress was very slow until the river became clear of ice. Six wing dams, extending from west shore of Island 41, near Pine Island, were constructed, and a wing dam above Teepeeota Point, running out from Minnesota shore, was commenced. There were put in place to June 24, inclusive, 8,779 cubic yards of rock and 18,564 cubic yards of brush.

*Minneiska to La Crosse.*—In local charge of Supt. W. A. Thompson. The United States plant to be used in this section of river was put in repair early in the spring. Operations were greatly retarded by high water and were not commenced until May 6, 1893. Ten wing dams were constructed, running out from east bank below La Crosse. One closing dam at La Plume Chute, and three wing dams from west bank near Root River, were also built. There were put in the work to June 24, inclusive, 8,700 cubic yards rock and 38,338 cubic yards brush. For work between Minneiska and Genoa there has been allotted from the appropriation of March 3, 1893, the sum of $60,000.

*Genoa to Prairie du Chien.*—In local charge of Supt. W. A. Thompson. Operations in the construction of dams and shore protections in this stretch of river have been carried on since April 18, 1893, under formal contract with Albert Kirchner, of Fountain City, Wis. Four wing dams running from right bank, and three from left bank below Genoa, have been completed, and a closing dam at Island 126 is well advanced.

There were put in the work to June 24, inclusive, 10,024 cubic yards rock and 14,417 cubic yards brush. Project and specifications have been approved for continuing work by contract in this locality under an allotment of $50,000 from appropriation of March 3, 1893. Proposals have been invited, and will be opened July 6, 1893.

*Glenhaven to Dubuque.*—In local charge of Supt. J. C. McElherne. Operations in this section of river in construction of dams and shore protections under contract with A. J. Whitney, of Rock Island, Ill., were not commenced, on account of high water, until June 17, 1893. A closing dam between Islands 220 and 221 has been commenced. There were put in the work to June 24, inclusive, 1,217 cubic yards rock and 1,186 cubic yards brush.

*Dubuque to Clinton.*—In local charge of Supt. J. C. McElherne. Operations in this portion of the river in construction of dams and shore protections under contract with Patterson Bros., of Keokuk, Iowa, were delayed by high water and not commenced until June 16, 1893.

A closing dam at Four Mile Island (228) was commenced. There were put in the work to June 24, inclusive, 1,635 cubic yards rock and 1,339 cubic yards brush. Project and specifications have been approved for continuing work by contract in this locality under an allotment of $50,000 from appropriation of March 3, 1893. Proposals have been invited, and will be opened July 6, 1893.

*Rock Island Rapids.*—In local charge of Supt. J. C. McElhern. The United States plant used on the rapids was put in good repair during the spring. Operations in construction of a wing dam (No. 11) opposite Duck Creek Chain were begun May 5, 1893, and carried on to end of June. The drillboat was put at work June 5 on the patch of rock below buoy 22, at foot of Duck Creek Chain, on Illinois side of channel, and remained there until the end of the fiscal year. Dredge *Phœnix* commenced on June 26 the removal of the old and abandoned water-power dike opposite Cottonwood Chain, the rock to be used in the construction of dams in vicinity of Duck Creek Chain. On June 22 work was begun on Dam No. 10, Iowa side, at Duck Creek Chain. There were put in place to June 24, inclusive, 6,037 cubic yards rock. An allotment of $40,000 has been made from the appropriation of March 3, 1893, for continuing work on the rapids and for work between Clinton and the head of the rapids.

*Buoys on Rock Island Rapids.*—The buoys having been repaired and repainted were reset April 8 to 13, 1893. There are now 30 buoys in the system, 27 of which were reset. The chain bolts of Nos. 17, 17½, and 25 were found to be broken, and will soon be repaired and replaced. All the range stakes were carefully examined and repaired.

*Keithsburg to Montrose.*—In local charge of Overseer J. R. Carpenter. The United States plant for this work has been repaired and placed in readiness. Operations, delayed by high water, will commence about July 1, 1893. An allotment of $50,000 for work in this locality has been made from the appropriation of March 3, 1893.

*Keokuk to Quincy.*—In local charge of Mr. M. Meigs, United States civil engineer. Operations in construction of dams and shore protections under formal contract with Thompson & Gray, of St. Charles, Mo., were begun April 13, 1893, and continued to the end of the fiscal year. The work has been much retarded by high water. A wing dam, about 700 feet long, on Iowa side, below mouth of Des Moines River, and 2,500 lineal feet of shore protection in vicinity of Alexandria, were constructed, and repairs were made to the Tully Island closing dam. There were put in place to June 24, inclusive, 8,570 cubic yards rock and 6,645 cubic yards brush.

*Improving Quincy Bay.*—In local charge of Mr. M. Meigs, United States civil engineer. Work in construction of a pile bulkhead at Whipple Creek, under contract with H. S. Brown, of Quincy, Ill., was commenced June 7, 1893, and continued to the end of the fiscal year. There were put in place to June 24, inclusive, 4,507 lineal feet oak piling, 17,663 feet, B. M., sheet piling, and 7,028 feet, B. M., pine waling timber.

*Quincy Bridge to Clarksville.*—In local charge of Supt. S. Edwards. The United States towboat *Coal Bluff* and fleet of barges are used in construction of dams and shore protections in this section of river. The plant was thoroughly repaired in the spring, went into commission April 15, 1893, and has continued operations to the close of the fiscal year. The work accomplished consisted in the building of Dams 5, 7, 8, 9, and 10, near foot of Hickory Chute; the extension of Dam 1, opposite Louisiana, and the raising of Dam 2, closing Buffalo Chute. About 1,500 lineal feet of shore protection was completed at Illinois shore above Hannibal bridge. There were put in place 9,648 cubic yards rock and 11,289 cubic yards brush. An allotment of $50,000 from appropriation of March 3, 1893, has been made for continuing work in this locality.

*Clarksville to Hamburg—Hamburg to Cap au Gris—Cap au Gris to Illinois River.*—In local charge of Lieut. William V. Judson, Corps of Engineers, U. S. Army. Allotments of $50,000, $75,000, and $60,000, respectively, have been made for contract work in the above-mentioned localities. Project and specifications have been approved. Proposals have been invited, and will be opened July 6, 1893.

*Illinois River to Missouri River.*—In local charge of Lieut. William V. Judson, Corps of Engineers, U. S. Army. An allotment of $90,000 from the appropriation of March 3, 1893, has been made for work in construction of dams and shore protections in this section of river by day's labor and Government plant. Operations will commence soon after July 1.

Very respectfully, your obedient servant,

C. W. Durham,
*Assistant Engineer.*

Maj. A. Mackenzie,
*Corps of Engineers, U. S. A.*

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## REPORT OF MR. C. W. DURHAM, ASSISTANT ENGINEER, ON BENCH MARKS AND GAUGES.

United States Engineer Office,
*Rock Island, Ill., June 10, 1893.*

Major: I have the honor to report the completion of a book of "Bench Marks and Gauges" applicable to the Mississippi River between Minneapolis and the mouth of the Missouri River.

Your assistants have been for several years collecting data for this book in addition to that contained in our book of 1879, but I have postponed the compilation of it until the Mississippi River Commission had carried their line of precise levels from the Gulf of Mexico to St. Paul, in order that our datum plane might be identical with theirs. The precise level line was finished in 1891, and we obtained the bench-mark descriptions, etc., in the spring of 1892. Since that time we have connected our line with theirs at a large number of points, in addition to the numerous connections made by them, thus making all our observations of high and low water stages, etc., available. In 1878 and 1879 a survey of the river from St. Paul to the mouth of the Illinois River was made by this office. The survey was made by ten different parties, covering as many sections of the river, and the levels were run with no especial care, nor were they, except in a few instances, checked; and yet the variation in result of our combination of lines of ordinary levels and the line of precise levels of the commission is only 0.274 foot, or a little over 3 inches, from the mouth of the Illinois River to St. Paul, a distance of 690 miles. From Grafton to Red Wing, 638 miles, the variation is 0.041 foot, or less than one-half inch; from Port Louisa to St. Paul, 440 miles, 0.043 foot, but at intermediate points the difference is at times nearly 2 feet. The above are examples of the offsetting of errors, so often observed in leveling.

Inasmuch as the commission have not fully determined the precise mean level of the Gulf of Mexico at Biloxi, Miss., their initial point, it was thought best to use in this book the Cairo datum, the one used by them, and all the elevations are in feet above that datum. The elevation of the Cairo datum is approximately 21.26 feet below the mean level of the Gulf of Mexico, so that to reduce our elevations to a sea-level datum it is only necessary to subtract 21.26 feet.

The book of "Bench Marks and Gauges" contains:

(1) An index of localities.

(2) A numbered descriptive list of bench marks. This list includes as many of our existing bench marks of 1878 and 1879 as were found to be reliable, a large number established by us since that time, and a liberal selection from the permanent bench marks of the commission, the latter being always given when located advantageously for use in connection with river improvement. The bench marks are 322 in number, or an average of 1 in 2 miles.

(3) A large number of standard low-water elevations. The low-water datum which has always been used as the standard in connection with the improvement of the Upper Mississippi is the low water of 1864, which is the lowest known except that of

1891. During the low water of 1877 (0.75 foot above low water of 1864) bench marks were established and water surfaces were taken at very numerous points, from which data, there being in existence several reliable low-water marks of 1864, we were able to make a close estimate of the elevation of extreme low water at any point between the Illinois River and St. Paul. The low water of 1891 was a remarkable one, a little lower than that of 1864 between Keokuk and the Illinois River, at the head of Des Moines Rapids and at the head of Rock Island Rapids, and nearly if not quite as low from Keokuk to St. Paul. Advantage was taken of the low water of 1891 to make water-surface observations all along the river, and the results prove our former calculations to be in most cases very nearly correct. Low-water elevations lower than those of 1864 are recorded. There are 115 low-water elevations given, an average of 1 in 6 miles, and always at localities sufficiently near together to permit of a close calculation of low-water elevations at intermediate points by interpolation. There are also a number of approximate low-water elevations given, which it is intended to verify at the first favorable opportunity.

(4) A large number of high-water elevations, many of which are permanently marked on stone and brick buildings. A comparison and study of the high-water marks have resulted in the adoption of the high water of 1880 as the standard from St. Paul to Hampton; that of 1888 from Rock Island to Jersey Landing, and 1883 at Alton. There are given 69 standard high-water elevations—an average of 1 in 10 miles, sufficient in number and so located as to render the calculation of elevation of high water at intermediate points easy and reliable.

(5) Elevations of the zeros of all the river gauges.

(6) Elevations of the lower chords of most of the bridges.

(7) A full description of all reliable and permanent gauges.

*Partial list of high and low water elevations and of the principal adjacent bench marks between St. Paul and mouth of Missouri River.*

[Elevations in feet above Cairo datum, which is 21.26 feet below sea level.]

| Locality. | Principal B. M. | | Standard high water.* | Standard low water.† | Remarks. |
|---|---|---|---|---|---|
| | No. | Elevation. | | | |
| St. Paul | 10 | 727.165 | 720.010 | 705.110 | U. S. E. gauges are correct. |
| Newport | 15 | 713.222 | 715.276 | 700.151 | |
| Hastings | 20 | 706.210 | 707.522 | 690.794 | Do. |
| Prescott | 24 | 715.233 | .......... | 689.865 | Gauge (see note *a*). |
| Diamond Bluff | 32½ | 698.085 | .......... | 686.712 | |
| Trenton | 106 | 694.802 | .......... | 685.750 | |
| Red Wing | 38 | 700.704 | 700.771 | 685.489 | |
| Waconta | 43 | 695.197 | .......... | 684.988 | |
| Frontenac | 44 | 695.138 | 699.680 | 684.944 | |
| Stockholm | 48 | 695.990 | .......... | 684.883 | |
| Lake City | 51 | 695.405 | 699.701 | 684.888 | |
| Reeds Landing | 55 | 706.320 | 699.415 | 684.642 | Do. |
| Do | 58 | 709.455 | .......... | 684.572 | |
| Wabasha | 60 | 697.677 | 697.167 | 681.826 | |
| Alma | 66 | 704.101 | 692.515 | 676.205 | |
| Minneiska | 72 | 687.058 | 686.117 | 671.007 | |
| Fountain City | 76 | 692.460 | 680.750 | 665.421 | |
| Winona | 87 | 679.128 | 677.356 | 660.339 | Gauge is correct. |
| Do | 88 | 687.945 | .......... | 659.703 | |
| Trempeleau | 98 | 681.324 | .......... | 655.664 | |
| Dakota | 102 | 672.943 | 668.728 | 651.715 | |
| La Crosse Bridge | 106 | 678.348 | 663.814 | 647.760 | U. S. E. gauge is correct. |
| La Crosse | 108 | 664.172 | .......... | 646.480 | Do. |
| Brownsville | 109 | 657.182 | 659.159 | 642.605 | |
| Genoa | 113 | 660.192 | 655.996 | 637.006 | |
| Victory | 114 | 660.559 | 654.225 | 635.508 | |
| De Soto | 115 | 646.679 | .......... | 633.962 | |
| Lansing | 118 | 646.507 | 651.917 | 632.336 | |
| Lynxville | 121 | 657.976 | 649.686 | 628.790 | |
| North McGregor | 127 | 651.315 | .......... | 625.454 | Gauge is correct. |
| Prairie du Chien | 126 | 651.093 | 646.906 | 625.379 | |
| South McGregor | 129 | 648.859 | .......... | 625.245 | |
| Clayton | 133 | 642.540 | 643.763 | 622.764 | |
| Glenhaven | 139½ | 640.617 | 640.617 | 620.787 | |
| Cassville | 144 | 642.288 | 637.469 | 615.879 | |
| Buena Vista | 147 | 647.473 | .......... | 614.861 | |
| Waupeton | 149 | 620.712 | .......... | 613.258 | |

[a] It is proposed at an early day to correct the gauge at Prescott and to establish a new one at Reeds Landing.

* Standard high water is that of 1880 from St. Paul to Hampton; of 1888, from Rock Island to Jersey Landing; of 1883, at Alton.

† Standard low water is that of 1864, except in vicinity of Alton, where 1872 is used.

*Partial list of high and low water elevations and of the principal adjacent bench marks between St. Paul and mouth of Missouri River*—Continued.

| Locality. | Principal B. M. | | Standard high water.* | Standard low water.† | Remarks. |
|---|---|---|---|---|---|
| | No. | Elevation. | | | |
| Finleys Landing | 150 | 638.814 | .......... | 611.890 | |
| Spechts Ferry | 154 | 635.865 | 631.575 | 610.288 | |
| East Dubuque | 159 | 634.417 | 627.260 | 605.590 | U. S. E. gauge is correct. |
| Dubuque | 161 | 626.222 | 627.349 | 605.470 | |
| Bellevue | 174 | 619.671 | 619.252 | 598.721 | |
| Savanna | 186 | 600.066 | 612.528 | 592.719 | |
| Sabula | 189 | 617.822 | 611.423 | 591.882 | Do. |
| Fulton | 191 | 617.419 | 607.490 | 587.080 | At elevator. |
| Clinton | 196½ | 586.480 | 606.930 | 586.480 | U. S. E. gauge is correct. |
| Albany | 198 | 615.816 | 605.376 | 585.423 | |
| Le Claire | 204 | 590.794 | 596.896 | 583.107 | |
| Hampton | 207 | 590.371 | 590.371 | 575.579 | |
| Rock Island | 211 | 597.492 | 580.969 | 562.369 | Do. |
| Muscatine Bridge | 221 | 572.298 | 568.195 | 551.401 | Do. |
| Muscatine | 222 | 571.845 | 568.079 | 551.285 | |
| New Boston | 228 | 565.175 | 560.495 | 544.259 | L. W. doubtful. |
| Keithsburg Bridge | 229½ | 543.515 | 558.465 | 543.515 | U. S. E. gauge is correct. |
| Keithsburg | 232 | 559.792 | 557.586 | 543.415 | |
| Oquawka | 235 | 554.128 | 553.054 | 537.030 | |
| Burlington Bridge | 237½ | 531.249 | 548.829 | 531.249 | |
| Dallas | 247 | 542.149 | 543.192 | 525.674 | |
| Pontoosuc | 248 | 543.236 | .......... | 524.426 | |
| Appanoose | 249 | 534.730 | 540.669 | .......... | |
| Fort Madison Bridge | 250 | 555.180 | 539.138 | 522.663 | Do. |
| Montrose | 254 | 550.363 | 533.063 | 520.440 | |
| Mechanics Rock | 255 | 521.821 | .......... | 518.571 | |
| Upper Lock | 256 | 527.857 | 528.858 | 516.863 | Do. |
| Middle Lock | 257 | 521.506 | 519.740 | 505.903 | In main river. |
| Lower Lock | 258 | 513.577 | 517.411 | 497.788 | U. S. E. gauge is correct. |
| Warsaw | 261 | 518.395 | 514.660 | 495.518 | |
| Alexandria | 264 | 516.429 | 513.970 | 495.466 | |
| Canton | 268 | 503.213 | 505.054 | 489.017 | |
| La Grange | 272 | 502.233 | 501.726 | 484.993 | |
| Quincy Bridge | 275 | 508.117 | 498.272 | 478.437 | R. R. gauge is correct. |
| Hannibal Bridge | 281 | 498.788 | 492.681 | 469.601 | Do. |
| Louisiana Bridge | 290 | 487.835 | 475.281 | 457.470 | Do. |
| Clarksville | 202 | 480.847 | 470.743 | 453.896 | |
| Hamburg | 299 | 465.878 | 465.251 | 446.372 | L. W. approximate. |
| Wildwood Landing | 301 | 459.043 | .......... | 444.953 | Do. |
| Hastings Landing | 306 | 462.886 | 457.038 | 435.951 | |
| Grafton | 313 | 466.119 | 446.861 | 424.454 | L. W. 1891. |
| Jersey Landing | 316 | 448.145 | 444.896 | .......... | |
| Alton | 317 | 449.305 | 444.930 | 415.821 | L. W. 1872; H. W. 1883. |

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* Standard high water is that of 1880 from St. Paul to Hampton; of 1888, from Rock Island to Jersey Landing; of 1883, at Alton.

† Standard low water is that of 1864, except in vicinity of Alton, where 1872 is used.

### DESCRIPTION OF BENCH MARKS.

10. B. M. in St. Paul, on lower bench of retaining wall of embankment of K. C. bridge, being highest point of ring cut in top of stone, marked: ⊙

15. B. M. at Newport Landing, 80 feet above upper warehouse, in top of ledge two-thirds up the river bank, being top of large ringbolt with ring.

20. B. M. on upstream corner river front of stone foundation of Le Duc's warehouse, just below bridge, marked: ○

24. P. B. M. at Prescott, on east pier of Chicago, Burlington and Northern Railway bridge, on north end of bridge seat, copper bolt, marked:
U. S.
⊙
P. B. M.

32½. B. M. copper bolt in stone platform front of lower warehouse, upper levee, Diamond Bluff, M cut in stone.

34. P. B. M. at Trenton Landing, at upper end of woods, and about 300 feet below old warehouse, being a copper bolt in tile 3½ feet, toward the river, from a blazed tree.

38. B. M. on iron pin let into large foundation stone under upstream corner, toward river, of City Freight Shed, marked: B. M.

43. B. M. at the mouth of South Channel, about 1,476 feet below the mouth of Ida Creek, at the foot of sand bluff, at about high-water elevation, on the north root of a large cottonwood tree, being a spike driven to the same elevation as old U. S. B. M. 34.

44. P. B. M. on Lake Pepin at Frontenac, at the Lake Side Hotel, 50 feet south from the driven well on the point, 7.0 feet of path leading to well, 13 feet east from the oak tree bearing T. B. M. 72, being copper bolt in tile about 3 feet under ground.

48. B. M. on elm tree at east end of Stockholm pier.

51. B. M. in Lake City, on Diamond Jo Elevator, 105 feet west of southeast corner, on foundation stone, at west end of stone pier, in southeast quarter of old cross.

55. P. B. M. at Reeds Landing, 246 feet below Knapp, Stout & Co.'s warehouse, on the south side of Water street, in the north door of S. Trautmann's store, in the south end of the stone doorstep, being a copper bolt, marked: $\overset{\text{U.S.}}{\underset{\text{P.B.M.}}{\odot}}$

58. P. B. M. top of cap on iron pipe set over P. B. M. 47, northeast corner A. Dunn's lot.

60. B. M. in Wabasha, at the elevator, between tracks on the north face of retaining wall and 3 feet above the corner of the wall, on the west side of runway under track to elevator, on the front part of top surface of lower corner of stone, marked: B. M.

66. B. M. top of foundation stone, land side, downstream corner of R. R. Kemper's building, next above M. Polin's warehouse, marked B ⊙ M, at Alma.

72. B. M. at Minneiska on doorstep of O'Neil's brick warehouse, upper corner, toward river.

76. B. M. in Fountain City, on northwest corner of Main and Eagle streets, at southeast corner Scherer's Hotel, on the water table, being the highest point inside of circle, marked B. M.

87. B. M. in Winona on east face of water tower on bottom surface of a deep notch cut in base stone, about 2 feet above ground.

88. B. M. on Keys' barn in lower Winona, on upstream end of the stone window sill of Keys' brick barn facing river, being highest point in rear part of old square.

98. B. M. on stone building between two brick buildings, 150 feet below Chicago, Burlington and Northern Railway depot at Trempeleau, 75 feet above railroad, on lower foundation stone, 4 feet below corner: □

102. B. M. in Dakota, on the water-tank foundation, at the lower side, front pier, on southeast corner of base stone, highest point in circle.

106. P. B. M. on west pier of Chicago, Milwaukee and Saint Paul Railway bridge above La Crosse, lower side of track, on downstream end of cap stone, copper bolt, leaded vertically, marked $\overset{\text{U.S.}}{\underset{\text{P.B.M.}}{\odot}}$

108. P. B. M. in La Crosse in west face of the land pier to wagon bridge, 5 feet from its north end and 3.5 feet above ground, being center of a copper bolt, leaded horizontally, marked $\overset{\text{U.S.}}{\underset{\text{P.B.M.}}{\odot}}$

109. B. M. at Brownsville on Western Progress building, downstream corner of bottom of door post, on upstream side of lower door on river side of building, on floor level.

113. B. M. in Genoa, on the last stone building in the town going south, on the side of the building facing the river, second floor, on the upstream corner of the stone door sill, being highest point in square.

114. P. B. M. in Victory on southeast corner of block 17, at northeast corner Terhune and Rice streets, on south abutment, west side of wagon bridge, on the corner top stone, 3 inches from end of wall, being top of copper bolt, marked $\overset{\text{U.S.}}{\underset{\text{P.B.M.}}{\odot}}$

115. P. B. M. in upper end of De Soto, on north side of Diamond Jo warehouse, 9 inches from west side, 5.3 above ground, being center mark in copper bolt: $\overset{\text{U.S.}}{\underset{\text{P.B.M.}}{\odot}}$

118. B. M. in Lansing, on southeast corner of door sill at downstream corner of G. Kerndt & Bros. warehouse.

131. B. M. on Bright's warehouse in Lynxville, on northeast corner of warehouse, on top of foundation, marked B. ⊙ M.

126. B. M. on Dousman House on downstream end of downstream door sill, being highest point in circle cut in stone.

127. P. B. M. in N. McGregor, on north side of North street, in O. A. Bratsberg's brick store, in water table, 1 foot east from the entrance, being top of copper bolt, leaded vertically, marked: $\overset{\text{U.S.}}{\underset{\text{P.B.M.}}{\odot}}$

129. T. B. M. in S. McGregor, at northwest corner of Main street and the railroad, at sidewalk entrance to Gregor McGregor's residence, on the river end of bottom step, on level with sidewalk, marked U. □ S., being highest point in square.

133. B. M. in upper end of Clayton, on the large stone mill, at west side of Chicago, Milwaukee and St. Paul Railway track, on the river front of the building, at the lower window and lower end of window sill, being top of ringbolt 1 inch above surface.

139½. H. W. 1880, cut in stone at side of door of Dr. Grinters's building at Glenhaven.

144. B. M. at Cassville, top of downstream end, downstream stone door sill of Herman Grimm's saloon.

147. P. B. M. in Buena Vista, at southeast corner of Meuth's store, 6 inches from south face, 4.3 feet above ground, in wall, being copper bolt marked:
U. S.
⊙
P. B. M.

149. B. M. on top of bowlder about 300 feet above landing at Waupeton.

150. P. B. M. at Finleys Landing, 649 feet below milepost 101–60, 180 feet above bridge 162, on right of way of railroad, 2 feet from south fence, 38 feet from center of track, copper bolt in tile set 3 feet under ground.

154. B. M. at Spechts Ferry, at northeast corner of Specht's house, on the water table, above corner a few inches, marked: B. ⊙ M., being highest point on front segment.

159. B. M. East Dubuque, under end of Dubuque Highway Bridge, on upstream foundation stone supporting triangular truss, on upstream corner of stone, marked: B. ⊙ M.

161. B. M. in Dubuque, on southeast corner of Linehan's boat store, 1½ feet above the corner, on water table, in center of buttress, marked: ⊙

174. B. M. in Bellevue, top of head of iron bolt, in top of downstream end of stone door sill, second floor, river front, of L. B. Potter's warehouse.

186. B. M. in Savanna, top of ringbolt in east end of south wall of cellar of elevator.

189. B. M. in Sabula, on round top of coping stone of second pier from Iowa side of Sabula bridge, downstream end.

191. P. B. M. at Fulton, on northeast corner of Cherry and Beach streets, copper bolt in south face of stone foundation wall to the Northern Illinois College, 3½ feet above ground, 14 inches from southwest corner of foundation.

196½. Zero of United States gauge cut on east side, near downstream end of pier of wagon bridge, west pier of long span at Clinton.

198. P. B. M. at Albany, on foundation of brick store of Harper & Son, copper bolt in west side, at southwest corner, marked: U. S. P. B. M.

204. B. M. at Le Claire, cut on top of southeast corner of ringbolt stone set towards river from warehouse, marked: ▭ B. M. I.

207. P. B. M. at Hampton, on stone foundation of Baker & Hayward's brick store on levee. Center of hole in copper bolt in north side of northwest corner, and is at the high-water mark of 1880, marked: U. S. P. B. M.

211. P. B. M. on base of stone tower of United States Arsenal stone building A, 1865, at lower end of Rock Island. Bolt in east side of northeast corner, about 4 feet from ground, marked: U. S. P. B. M.

221. P. B. M. at Muscatine, on north abutment of Wagon Bridge, 50 meters north of station at Muscatine. Bolt in northeast corner of abutment, marked: U. S. P. B. M.

222. P. B. M. at Muscatine, on waterworks chimney. Bolt in north face of chimney, about 3½ feet from ground, marked: U. S. P. B. M.

228. P. B. M. at New Boston, on foundation of Keokuk Northern Line Packet Co.'s warehouse. Bolt in north wall near northeast corner, in top of stone foundation, 0.7 meter from ground, marked: U. S. P. B. M.

229½. Zero of gauge cut by United States on west side of first pier east of draw of Keithsburg Bridge.

232. B. M. at Keithsburg, on stone doorstep of brick building, northwest corner Main and Second streets, extreme west doorway and west side of same on Main street.

235. B. M. at Oquawka, doorstep of Journal Printing Office, raised portion, west side.

237½. Zero United States gauge cut in east side of first pier west of pivot pier.

247. B. M. spike in north side of foundation of mill at Dallas, 12 feet from lower side of Dallas City Flour Mill chimney.

248. B. M. at Pontoosuc, on upper surface of dressed stone joining water sill at east face of northeast corner of Schaum's Flour Mill. (Note.—This B. M. is covered by a wall, but the outside edge of the stone can be found.)

249. B. M. spike in root of cottonwood tree at foot of road coming down to river, below Stone Bridge, at Appanooce.

250. B. M. at Fort Madison, on top layer of downstream end of Iowa abutment, at southwest corner of stone, Atchison, Topeka and Santa Fe Bridge.

254. P. B. M. at Montrose. Bolt horizontal in upper foundation stone of brick store building on south corner Main and Cedar streets, on east side 3 feet from north corner, marked: U. S. P. B. M.

255. B. M. top of Mechanics Rock.

256. P. B. M. at Nashville, bolt vertical in top of coping of west wall near southwest tower of Guard Lock, marked: U. S. P. B. M.

257. P. B. M. above Keokuk. Bolt vertical in coping of west wall of sluiceway at south end of Middle Lock.

258. P. B. M. at Keokuk. Bolt vertical in coping of shore side of Lower Lock. B. M. is in recess between stone steps and stone pier of lower tower on south side of pier.

261. B. M. at Warsaw, upstream end of downstream stone window sill, river front of Eckbohm, Dross & Co., marked: ⊙ B. M.

264. B. M. at Alexandria, on downstream corner of stone doorsill, river front door of brick building, at upper end of town, belonging to C. Becker.

268. B. M. at Canton, on top of foundation northeast corner Carnegy's warehouse.

272. B. M. at La Grange, on downstream end of second stone doorsill from north end of east front of D. C. Skinner's brick building.

275. B. M. at Quincy Bridge, upstream corner toward shore of coping stone of upstream end of west abutment, marked, ⊙.

281. B. M. at Hannibal Bridge on northeast corner coping stone west abutment, marked ⊙.

299. P. B. M. at Louisiana Bridge, copper bolt set vertically in top surface of top stone forming the northeast corner of the west abutment of bridge over Mississippi River.

P. B. M., bolt horizontal in southeast corner stone of Carroll House, Clarksville, Mo. Stone is at head of stairs leading to basement. Bolt set in south face of stone about 10 inches above sidewalk.

299. B. M. at Hamburg, top of upstream outer corner of stone wall in front of H. Broadfisher's, marked ⊙.

301. P. B. M., point one-half inch from south corner and one-half inch from east side of shore-line triangulation stone, 38 meters east of river bank and about 250 meters below Island 482, midway opposite two houses on Westport Island, a new house quite near B. M., and a warehouse a little way below "Wildwood."

306. P. B. M., bolt horizontal in north face of large bowlder, partly imbedded, about 40 meters around east from northwest corner of bluff rocks below Hastings Landing; about 225 meters below warehouse on land of E. B. Brown. It is third large bowlder at foot of hill on north side of corner west from top of bank of small branch that empties in river below warehouse, and is about 8 meters east from fence that leads about southwest from east side of warehouse at landing.

313. P. B. M., bolt in east end of doorstep of east door in Allen's brick building, adjoining Grafton Flour Mills. It is 104 millimeters from front surface of step.

316: B. M. at Jersey Landing, top of ringbolt at downstream end, corner toward river of stone warehouse of T. F. Hausell.

317. P. B. M., bolt vertical in east end of water table on south side of Alton Waterworks building, in sixth window from corner.

Very respectfully, your obedient servant,

C. W. DURHAM,
*Assistant Engineer.*

Maj. A. MACKENZIE,
*Corps of Engineers, U. S. A.*

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## Z 3.

## IMPROVEMENT OF DES MOINES RAPIDS, MISSISSIPPI RIVER.

There was available for this work July 1, 1892, the sum of $5,842.43. During the year a brick machine shop was built at the lower lock of the canal and the same was provided with steam connections and the necessary tools and appliances. A small amount of riprap rock was placed in repairs to canal embankment.

It is proposed with the balance available to rebuild in a substantial manner the guide piers above the Guard Lock and to remove some projecting points of rock in the channel below Montrose, Iowa.

No further appropriation is required for the completion of this improvement in accordance with approved project.

*Abstract of appropriations.*

| | |
|---|---|
| By act approved— | |
| June 23, 1866 | $200,000 |
| March 2, 1867 | 500,000 |
| July 25, 1868 (allotment) | 300,000 |
| April 10, 1869 (allotment) | 178,200 |
| December 23, 1869 | 200,000 |
| July 11, 1870 | 400,000 |
| January 18, 1871 | 341,000 |
| March 3, 1871 | 250,000 |
| June 10, 1872 | 400,000 |
| March 3, 1873 | 400,000 |
| June 23, 1874 | 400,000 |
| March 3, 1875 | 480,000 |
| August 14, 1876 | 230,000 |
| June 18, 1878 (allotment) | 62,500 |
| March 3, 1879 | 25,000 |
| June 14, 1880 | 20,000 |
| March 3, 1881 | 25,000 |
| By act passed August 2, 1882 | 30,000 |
| By act approved July 5, 1884 | 50,000 |
| By act approved August 5, 1886 | 26,250 |
| By act of August 11, 1888 | 35,000 |
| By act of September 19, 1890 | 22,000 |
| | 4,574,950 |

*Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $5,842.43 |
| June 30, 1893, amount expended during fiscal year | 3,161.98 |
| July 1, 1893, balance unexpended | 2,681.45 |

## Z 4.

## OPERATING AND CARE OF DES MOINES RAPIDS CANAL AND DRY DOCK.

The Des Moines Canal was open for navigation during the year 237 days, during which time there passed through it 670 steamboats and 234 barges, carrying 10,846 passengers, 31,318 tons of merchandise, and 53,257 bushels of grain. There also passed through the canal 80,190,519 feet of lumber, 16,350,200 feet of logs, 29,121,020 shingles, and 28,896,260 laths.

The expenses of operating and caring for the Des Moines Rapids Canal and Dry Dock, including extensive dredging and the ordinary repairs to gates, machinery, and plant during the past year, have been $51,104.12. These expenses are provided for by an indefinite appropriation made by act of March 3, 1881.

It will probably be necessary to rebuild the gates at lower lock during the coming year, and ordinary repairs to the other gates, the culverts, and canal embankment will be needed.

A large amount of dredging was done during the past year, and more will be needed during coming year.

The dry dock has been constantly in use, and, at times, when not required for repairs to portions of the Government plant, boats and barges belonging to private parties have been docked and repaired. The dockage fees collected from private parties during the fiscal year amounted to $138.50.

A storage shed was built at the lower end of the dock. The expense of operating the canal is slightly increased by operating the dock as an accessory work, but such increase is more than offset by the facilities furnished for repair of Government boats and the amounts received from dockage fees. The boom, constructed in accordance with act of Congress for connecting outer wall of the canal with the pier of the Keokuk and Hannibal Bridge, requires repairs and must be taken into the canal at the close of navigation and put out again in the spring. An item for the expense of such repairs and labor is included in estimate of cost of operating and caring for canal for the coming fiscal year.

Tables are given herewith showing details of expenditure and traffic, and comparative expenditure and traffic statements are submitted. A list of vessels docked at the dry dock is appended.

The operating and care of the canal and dry dock are in the immediate charge of Mr. M. Meigs, United States civil engineer, whose report is appended.

*Abstract of appropriations.*

| | |
|---|---|
| By act approved— | |
| April 30, 1878 | $7,500.00 |
| June 18, 1878 (allotment) | 32,500.00 |
| March 3, 1879 | 40,000.00 |
| June 14, 1880 | 30,000.00 |
| March 3, 1881, for fiscal year ending— | |
| June 30, 1882 | 45,000.00 |
| June 30, 1883 | 75,000.00 |
| June 30, 1884 | 47,000.00 |
| June 30, 1885 | 40,500.00 |
| June 30, 1886 | 43,000.00 |
| June 30, 1887 | 44,000.00 |
| June 30, 1888 | 42,000.00 |
| June 30, 1889 | 39,000.00 |
| June 30, 1890 | 43,837.97 |
| June 30, 1891 | 43,995.80 |
| June 30, 1892 | 44,000.00 |
| June 30, 1893 | 58,000.00 |
| Total | 675,333.77 |

*Money statement.*

| | | |
|---|---|---|
| July 1, 1892, balance on hand | | $32.88 |
| June 30, 1893, amount drawn from Treasury under indefinite appropriation | $51,000 | |
| June 30, 1893, amount called for but not received | 7,000 | |
| | | 58,000.00 |
| | | 58,032.88 |
| June 30, 1893, amount expended during fiscal year | | 57,057.21 |
| June 30, 1893, balance on hand | | 975.67 |
| July 1, 1893, outstanding liabilities | | 1,628.16 |

*List of vessels docked at the dry dock at the Des Moines Rapids Canal during the fiscal year ending June 30, 1893.*

| Designation. | Date of entering dock. | Date of leaving dock. |
|---|---|---|
| Steamer Lotus | 1892.<br>July 5 | 1892.<br>July 9 |
| Dump boat D | July 12 | July 15 |
| Dump boat No. 8 | July 15 | July 18 |
| Towboat Fury | July 25 | July 27 |
| Dredge Ajax | July 28 | Aug. 2 |
| Towboat Coal Bluff | July 28 | Sept. 12 |
| Flat No. 40 | Aug. 2 | Aug. 5 |
| Flat No. 43 | Aug. 2 | Aug. 3 |
| Flat No. 98 | Aug. 2 | Aug. 3 |
| Flat No. 30 | Aug. 3 | Aug. 9 |
| Flat No. 82 | Aug. 3 | Aug. 5 |
| Dredge Phœnix | Aug. 5 | Aug. 9 |
| Flat No. 32 | Aug. 5 | Aug. 12 |
| Flat No. 79 | Aug. 5 | Aug. 9 |
| Flat C | Aug. 9 | Aug. 12 |
| Flat X | Aug. 9 | Aug. 20 |
| Flat G | Aug. 12 | Aug. 13 |
| Dredge Vulcan | Aug. 9 | Aug. 16 |
| Launch Iris | Aug. 12 | Aug. 13 |
| Flat No. 50 | Aug. 12 | Aug. 24 |
| Dump boat D | Aug. 16 | Aug. 20 |
| Pipe boat No. 1 | Aug. 24 | Aug. 27 |
| Dredge Vulcan | Aug. 20 | 1893.<br>June 26 |
| Quarter boat No. 46 | Aug. 24 | 1892.<br>Sept. 28 |
| Launch Iris | Sept. 3 | Sept. 3 |
| Pipe boat No. 2 | Sept. 9 | Sept. 17 |
| Pipe boat No. 4 | Sept. 17 | Sept. 22 |
| Pipe boat No. 3 | Sept. 28 | Oct. 7 |
| Flat No. 33 | Sept. 28 | Oct. 8 |
| Dump boat No. 1 | Oct. 8 | Oct. 15 |
| Dump boat C | Oct. 8 | Oct. 20 |
| Pipe boat No. 1 | 1892.<br>Oct. 15 | 1892.<br>Oct. 17 |
| Dump boat B | Oct. 20 | 1893.<br>Apr. 5 |
| Steamer General Barnard | Nov. 3 | 1892.<br>Nov. 4 |
| Dump boat C | Nov. 5 | Nov. 13 |
| Dredge Phœnix | Nov. 7 | Nov. 20 |
| Dump boat No. 4 | Nov. 7 | Nov. 20 |
| Launch Iris | Nov. 20 | 1893.<br>Apr. 5 |
| Towboat Success | Nov. 20 | May 13 |
| Dredge Ajax | Nov. 20 | Apr. 11 |
| Dump boat D | Nov. 20 | Apr. 6 |
| Building boat No. 53 | Nov. 20 | June 30 |
| Building boat No. 63 | Nov. 20 | Apr. 5 |
| Quarter boat No. 56 | Nov. 20 | Apr. 5 |
| Launch Edith | Nov. 20 | Apr. 5 |
| Pile-driver No. 58 | Nov. 20 | Apr. 5 |
| Dump boat B | Oct. 20 | Apr. 5 |
| Dump boat D | Nov. 20 | Apr. 5 |
| Towboat Vixen | 1893.<br>Apr. 11 | Apr. 11 |
| Dump boats 5 and 6 | Apr. 15 | Apr. 17 |
| Steamer Gem City * | Apr. 5 | Apr. 6 |
| Steamer City of Quincy* | Apr. 9 | Apr. 9 |
| Steamer Kit Carson* | Apr. 14 | Apr. 15 |
| Steamer Patrol | Apr. 17 | May 13 |
| Quarter boat Illinois | Apr. 13 | May 31 |
| Steamer Josephine* | May 21 | June 3 |
| Quarter boat No. 46 | June 26 | June 29 |
| Barge No. 87 | June 26 | June 29 |
| Barge No. 62 | June 26 | June 29 |
| Barge No. 88 | June 29 | (†) |

* Belongs to private parties.

† Still in dock.

*Expenditures for operating and care of Des Moines Rapids Canal for fiscal year ending June 30, 1893.*

| Month. | Office and administration. | | | | Canal and locks. | | | |
|---|---|---|---|---|---|---|---|---|
| | Salaries. | Supplies. | Miscellaneous. | Total. | Labor. | Supplies. | Current repairs. | Total. |
| 1892. | | | | | | | | |
| July | $595.00 | $11.65 | $21.28 | $627.93 | $1,425.00 | $263.62 | $186.60 | $1,875.22 |
| August | 375.00 | .......... | .......... | 375.00 | 1,510.00 | 123.04 | 406.26 | 2,039.30 |
| September | .......... | 13.20 | .......... | 13.20 | 51.33 | 209.51 | 417.75 | 678.59 |
| October | 250.00 | 9.80 | .......... | 259.80 | 1,430.00 | 301.47 | 540.68 | 2,272.15 |
| November | 750.00 | .......... | .......... | 750.00 | 2,912.50 | 156.35 | 903.08 | 3,971.93 |
| December | 500.00 | 14.95 | .......... | 514.95 | 1,270.00 | 17.98 | 717.17 | 2,005.15 |
| 1893. | | | | | | | | |
| January | 500.00 | .......... | 21.28 | 521.28 | 1,270.00 | 84.61 | 566.58 | 1,921.19 |
| February | .......... | 18.45 | .......... | 18.45 | .......... | 19.16 | 63.29 | 32.45 |
| March | 1,375.00 | 26.98 | 28.90 | 1,430.88 | 2,573.34 | 189.47 | 1,352.90 | 4,115.71 |
| April | 437.50 | 24.00 | 40.47 | 501.97 | 1,470.00 | 146.58 | 455.45 | 2,072.03 |
| May | .......... | 4.60 | 26.80 | 31.40 | 235.00 | 211.91 | 371.08 | 817.99 |
| June | 937.50 | 13.50 | .......... | 951.00 | 3,317.50 | 438.94 | 841.51 | 4,597.95 |
| Total | 5,720.00 | 137.13 | 138.73 | 5,995.86 | 17,464.67 | 2,162.64 | 6,822.35 | 26,449.66 |

*Expenditures for operating and care of Des Moines Rapids Canal for fiscal year ending June 30, 1893*—Continued.

| Month. | Dredging canal. | | | | Grand total. |
|---|---|---|---|---|---|
| | Labor. | Supplies. | Current repairs. | Total. | |
| 1892. | | | | | |
| July | ........... | $629.44 | $84.97 | $714.41 | $3,217.56 |
| August | $3,388.11 | 1,237.09 | 557.56 | 5,182.76 | 7,597.06 |
| September | 808.33 | 234.21 | 427.08 | 1,469.62 | 2,161.41 |
| October | 40.00 | 147.30 | 91.25 | 278.55 | 2,818.50 |
| November | 148.18 | 202.23 | 703.93 | 1,054.34 | 5,776.27 |
| December | ........... | ........... | 231.13 | 231.13 | 2,731.23 |
| 1893. | | | | | |
| January | ........... | 1.90 | 1,396.94 | 1,398.84 | 3,841.31 |
| February | ........... | ........... | 23.87 | 23.87 | 124.77 |
| March | ........... | ........... | 1,067.11 | 1,067.11 | 6,613.70 |
| April | 1,090.82 | 175.63 | 283.84 | 1,550.29 | 4,124.29 |
| May | ........... | 484.92 | 301.33 | 786.25 | 1,635.64 |
| June | 3,237.33 | 1,368.81 | 295.29 | 4,901.43 | 10,650.36 |
| Total | 8,712.77 | 4,481.53 | 5,464.30 | 18,658.60 | 51,104.12 |

*Comparative expenditures of operating and care of Des Moines Rapids Canal for the fiscal years 1882–'93.*

| Year. | Office and administration. | | | | Canal and locks. | | | |
|---|---|---|---|---|---|---|---|---|
| | Salaries. | Supplies. | Miscellaneous. | Total. | Labor. | Supplies. | Repairs. | Total. |
| 1882 | $3,710.00 | $161.69 | $550.62 | $4,422.31 | $21,122.70 | $1,654.06 | $1,946.03 | $24,722.79 |
| 1883 | 4,821.12 | 289.86 | 449.52 | 5,560.50 | 25,818.40 | 2,216.87 | 3,203.01 | 31,238.28 |
| 1884 | 5,045.22 | 209.12 | 665.62 | 5,519.96 | 17,654.23 | 4,344.51 | 1,291.20 | 23,289.94 |
| 1885 | 5,015.00 | 245.31 | 573.88 | 5,834.19 | 17,615.97 | 1,995.92 | 5,237.88 | 24,849.77 |
| 1886 | 5,225.00 | 209.12 | 432.10 | 5,866.22 | 17,731.76 | 2,226.23 | 5,652.87 | 25,610.86 |
| 1887 | 4,375.00 | 85.19 | 424.48 | 4,884.67 | 18,326.23 | 2,752.80 | 3,775.59 | 24,854.62 |
| 1888 | 4,870.00 | 154.04 | 481.70 | 5,505.74 | 16,892.82 | 1,942.94 | 7,972.29 | 26,808.05 |
| 1889 | 3,750.00 | 26.80 | 318.82 | 4,095.62 | 17,241.79 | 2,277.97 | 3,689.20 | 23,208.96 |
| 1890 | 4,425.00 | 120.84 | 238.03 | 4,783.87 | 18,245.07 | 2,376.55 | 7,848.88 | 28,470.50 |
| 1891 | 5,175.00 | 162.76 | 113.88 | 5,451.14 | 18,785.73 | 2,725.27 | 11,863.31 | 33,374.31 |
| 1892 | 4,495.00 | 156.04 | 210.75 | 4,861.79 | 18,099.98 | 1,612.98 | 5,012.20 | 24,725.16 |
| 1893 | 5,720.00 | 137.13 | 138.73 | 5,995.86 | 17,464.67 | 2,162.64 | 6,822.35 | 26,449.66 |

| Year. | Dredging canal. | | | | | Miscellaneous. | Grand total. |
|---|---|---|---|---|---|---|---|
| | Labor. | Supplies. | Repairs. | Contract. | Total. | | |
| 1882 | $2,340.43 | $572.09 | $846.58 | $14,080.39 | $17,839.49 | $68.75 | $47,053.34 |
| 1883 | 4,765.93 | 1,538.80 | 598.04 | 30,666.17 | 37,568.94 | 3,564.07 | 77,931.79 |
| 1884 | 7,485.45 | 4,789.32 | 1,262.02 | ........... | 13,536.79 | 536.73 | 42,883.42 |
| 1885 | 3,353.12 | 8,580.69 | 1,888.73 | ........... | 13,822.54 | ........... | 44,506.50 |
| 1886 | 4,984.55 | 3,017.49 | 3,530.41 | ........... | 11,532.45 | ........... | 43,009.53 |
| 1887 | 6,149.45 | 3,810.12 | 2,453.98 | ........... | 12,413.55 | ........... | 42,152.84 |
| 1888 | 5,084.77 | 2,267.62 | 1,808.85 | ........... | 9,161.24 | 1,327.32 | 42,802.35 |
| 1889 | 5,573.56 | 3,528.06 | 2,479.17 | ........... | 11,580.79 | ........... | 38,885.37 |
| 1890 | 3,196.58 | 1,260.78 | 6,284.07 | ........... | 10,741.43 | ........... | 43,995.85 |
| 1891 | 3,563.51 | 1,906.63 | 702.61 | ........... | 6,172.75 | ........... | 44,998.20 |
| 1892 | 11,333.23 | 6,370.52 | 4,259.47 | ........... | 21,963.22 | ........... | 51,550.17 |
| 1893 | 8,712.77 | 4,481.53 | 5,464.30 | ........... | 18,658.60 | ........... | 51,104.12 |

*Traffic statement of the Des Moines Rapids Canal for the fiscal year ending June 30, 1893.*

| Month. | Boats up. | Boats down. | Barges up and down. | Passengers. | Merchandise. | Grain. | Lumber. | Logs. | Shingles. | Lath. | Lockage at one lock. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1892. | | | | | *Tons.* | *Bushels.* | *Feet.* | *Feet.* | *Number.* | *Number.* | |
| July | | | 25 | 2,083 | 2,246 | 6,547 | ........ | ........ | ........ | ........ | 70 |
| August | 94 | 49 | 49 | 4,060 | 5,795 | 8,155 | 5,700,000 | ........ | 880,000 | 548,000 | 200 |
| September | 55 | 47 | 21 | 956 | 2,577 | 8,400 | 30,639,283 | 6,100,000 | 12,970,770 | 12,450,710 | 333 |
| October | 44 | 42 | 39 | 219 | 2,008 | 10,100 | 28,936,808 | 9,450,200 | 10,346,500 | 11,497,800 | 344 |
| November | 15 | 20 | 20 | ........ | ........ | ........ | 12,657,428 | ........ | 4,923,750 | 4,399,750 | 83 |
| 1893. | | | | | | | | | | | |
| March | 1 | 2 | 11 | ........ | ........ | ........ | ........ | ........ | ........ | ........ | 5 |
| April | 44 | 23 | 20 | 18 | 6,953 | 9,825 | ........ | 800,000 | ........ | ........ | 98 |
| May | 61 | 8 | 13 | 1,430 | 5,492 | ........ | ........ | ........ | ........ | ........ | 16 |
| June | 74 | 17 | 36 | 2,080 | 8,247 | 10,230 | 2,257,000 | ........ | ........ | ........ | 327 |
| Total | 445 | 225 | 234 | 10,846 | 33,318 | 53,257 | 80,190,519 | 16,350,200 | 29,121,020 | 28,896,260 | 1,476 |

*Comparative traffic statement showing the total traffic that has passed through the canal since its opening in 1877 by fiscal years ending June 30.*

| Fiscal year. | Steamboats. | Barges. | Passengers. | Merchandise. | Grain. | Lumber. | Logs. | Laths. | Shingles. | Lockage at one lock. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | *Tons.* | *Bushels.* | *Feet.* | *Feet.* | *Lumber.* | *Lumber.* | |
| 1878 | 670 | 548 | ........ | 53,346 | 737,415 | 25,000,000 | ........ | 4,000,000 | 3,700,000 | 824 |
| 1879 | 802 | 454 | 5,088 | 64,658 | 2,192,642 | 33,347,612 | 8,086,000 | 8,721,796 | 11,749,000 | 1,564 |
| 1880 | 967 | 651 | 13,231 | 78,989 | 2,197,469 | 21,832,478 | 13,160,960 | 27,863,640 | 20,651,000 | 2,497 |
| 1881 | 840 | 276 | 10,003 | 44,962 | 1,154,092 | 52,256,235 | 11,013,410 | 11,657,655 | 15,091,000 | 1,339 |
| 1882 | 760 | 444 | 8,588 | 29,043 | 781,817 | 17,150,011 | 4,475,000 | 3,112,825 | 4,885,250 | 2,292 |
| 1883 | 1,107 | 705 | 9,192 | 43,350 | 729,174 | 18,093,325 | 1,040,000 | 11,558,000 | 4,435,000 | 1,353 |
| 1884 | 913 | 245 | 13,057 | 54,215 | 470,580 | 57,018,151 | 9,399,764 | 15,924,645 | 25,182,250 | 1,908 |
| 1885 | 889 | 169 | 18,065 | 54,120 | 776,432 | 43,119,797 | 2,779,670 | 13,473,205 | 25,018,750 | 1,270 |
| 1886 | 784 | 218 | 22,221 | 56,001 | 465,681 | 22,769,823 | 3,195,360 | 4,302,800 | 8,253,000 | 755 |
| 1887 | 990 | 318 | 30,797 | 52,815 | 366,432 | 178,754,876 | 24,827,000 | 19,961,781 | 90,450,922 | 1,717 |
| 1888 | 595 | 235 | 8,330 | 33,160 | 143,037 | 106,827,752 | 34,505,000 | 83,642,450 | 49,848,840 | 1,749 |
| 1889 | 1,022 | 288 | 22,880 | 50,008 | 381,559 | 118,505,045 | 26,333,820 | 50,221,090 | 37,413,810 | 1,941 |
| 1890 | 924 | 477 | 14,529 | 71,453 | 397,788 | 146,078,329 | 26,689,300 | 44,316,167 | 73,540,370 | 1,827 |
| 1891 | 878 | 357 | 15,801 | 45,217 | 364,878 | 193,358,089 | 37,176,150 | 59,350,595 | 87,259,090 | 1,896 |
| 1892 | 577 | 191 | 10,260 | 12,228 | 63,210 | 140,654,084 | 24,514,000 | 39,476,926 | 61,141,137 | 1,233 |
| 1893 | 670 | 234 | 10,846 | 33,318 | 53,257 | 80,190,519 | 16,350,200 | 29,121,020 | 28,896,260 | 1,476 |

*Dates of opening and closing of canal for all years since its opening to navigation.*

| Years. | Canal opened. | Canal closed. | River opened. | River closed. | Highest water. | | Lowest water. | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Date. | Feet. | Date. | Feet. |
| 1877 | Aug. 22 | Dec. 10 | Feb. 17 | Dec. 10 | Feb. — | 20.55 | Sept. — | 0.65 |
| 1878 | Mar. 8 | Nov. 28 | Open ... | Dec. 20 | June 11 | 12.05 | Sept. 22 | 1.45 |
| 1879 | Mar. 17 | Dec. 9 | Mar. 6 | Dec. 26 | June 2 | 8.45 | Oct. 4 | 1.00 |
| 1880 | Mar. 8 | Nov. 19 | Jan. 5 | Dec. 8 | June 29 | 17.50 | Aug. 24 | 2.05 |
| 1881 | Apr. 16 | Oct. 17 | Mar. 25 | No close | Oct. 29 | 18.95 | Aug. 29 | 2.75 |
| 1882 | May 6 | Nov. 25 | Open ... | Dec. 15 | Apr. 25 | 15.90 | Oct. 5 | 2.65 |
| 1883 | Apr. 13 | Dec. 6 | Mar. 1 | Dec. 27 | May 8 | 15.45 | Sept. 22 | 2.10 |
| 1884 | Apr. 1 | Nov. 23 | Mar. 15 | Dec. 30 | Mar. 31 | 16.80 | Aug. 25 | 2.80 |
| 1885 | Apr. 1 | Nov. 24 | Mar. 14 | Dec. 14 | Mar. 15 | 12.80 | Nov. 30 | 3.40 |
| 1886 | Apr. 1 | Nov. 21 | Mar. 15 | Dec. 2 | May 6 | 15.95 | Dec. 1 | 0.50 |
| 1887 | Mar. 28 | Nov. 23 | Feb. 11 | Dec. 21 | Feb. 12 | 11.60 | Nov. 28 | 0.00 |
| 1888 | Mar. 29 | Nov. 22 | Mar. 1 | No close | May 16 | 19.65 | Dec. 26 | —0.80 |
| 1889 | Mar. 18 | Nov. 23 | Mar. 3 | Feb. 24 | Feb. 26 | 10.75 | Dec. 5 | —0.70 |
| 1890 | Apr. 1 | Nov. 20 | Jan. 28 | Jan. 21 | June 30 | 12.60 | Jan. 8 | —2.40 |
| 1891 | Apr. 1 | Nov. 21 | Open ... | No close | Mar. 29 | 10.89 | Nov. 30 | —1.60 |
| 1892 | Apr. 1 | Nov. 23 | Feb. 2 | Dec. 23 | June 30 | 19.25 | Dec. 18 | —0.80 |
| 1893 | Apr. 1 | ........ | Mar. 10 | ........ | ........ | ........ | ........ | ........ |

*Amount of material removed from the Des Moines Rapids Canal from June 30, 1878, to June 30, 1893.*

| Fiscal years. | Removed by United States dredges. | Removed by teams. | Removed by contract. | Total. |
|---|---|---|---|---|
| | *Cubic yds.* | *Cubic yds.* | *Cubic yds.* | *Cubic yds.* |
| 1879 | 8,700 | | | 8,700 |
| 1880 | 26,496 | 1,228 | 11,553 | 39,277 |
| 1881 | 9,003 | | | 9,003 |
| 1882 | 18,031 | | 49,758 | 67,789 |
| 1883 | 22,717 | | 90,858 | 113,575 |
| 1884 | 52,616 | | | 52,616 |
| 1885 | 38,097 | | | 38,097 |
| 1886 | 65,970 | | | 65,970 |
| 1887 | 78,537 | | | 78,537 |
| 1888 | 47,333 | | | 47,333 |
| 1889 | 86,278 | | | 86,278 |
| 1890 | 23,830 | | | 23,830 |
| 1891 | 46,751 | | | 46,751 |
| 1892 | 149,618 | | | 149,618 |
| 1893 | 113,954 | | | 113,954 |
| Grand total | | | | 941,328 |

In addition to the above there have been removed from the head of the channel at Montrose, during the fiscal years ending June 30, 1883, 1884, and 1885, 16,643, 25,315, and 6,007 cubic yards of material, respectively; total, 47,965 cubic yards.

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## REPORT OF MR. M. MEIGS, U. S. CIVIL ENGINEER.

UNITED STATES ENGINEER OFFICE,
*Keokuk, Iowa, July 1, 1893.*

MAJOR: I have the honor to submit the following report on "operating and care of Des Moines Rapids Canal and Dry Dock" for the fiscal year ending June 30, 1893. The canal was open for navigation 237 days, and closed 128. Navigation closed November 23, 1892, and opened April 1, 1893, though a few boats were locked through by hand after and before these dates, the steam machinery being laid up.

High water prevailed July 1 to 30, 1892, and April 1 to June 30, 1893, the highest stage being reached being 19.25 feet above low water of 1864. The water fell to an ordinary low stage during the fall months of 1892. The river closed December 23, 1892, and the ice moved out of the rapids March 9, 1893.

*Repairs to canal embankment.*—No repairs to the canal embankment have been required, except just above the middle lock, where old leaks broke out afresh and kept the dry dock constantly wet. While these leaks were not at all dangerous, they steadily increased year by year, and, at times when the river was too high to drain the dock without pumping, the leakage severely taxed the 12-inch centrifugal pump used for that purpose. In October, 1892, a small steam pile-driver was rigged up temporarily, and 350 linear feet of the bank between the canal and the dock were lined with sheet piling. Three-inch plank, 12 feet long, tongued and grooved, were used and driven the full length, a trench 2 feet deep having first been excavated to drive them in.

This work was completed November 16, and proved entirely effectual, completely cutting off all the leaks and making the dock very easy to pump.

*Repairs to gates, machinery, and buildings.*—The rebuilding of the lower lock gates has been again deferred, as careful examination showed them to be capable of running another season without rebuilding. At present the middle lock gates are in the worst condition of any, and will have to be extensively repaired next winter. Small repairs were made to the gates at all the locks. Some of the hydraulic pipes at the head of the middle lock were repaired, and a broken gate (culvert) at the upper end of the lower lock was replaced, by the assistance of a diver. All machinery was overhauled, and new packing was put in the hydraulic cylinders. At the lower lock one of the cylinders in the upper outside tower was burst by frost, and will have to be replaced. Temporary repairs were made, to enable it to go through the present season.

*Repairs to plant.*—The dredges *Phœnix*, *Vulcan*, and *Ajax* and towboats *Fury*, *Vixen*, *Lucia*, and *Iris*, engaged in the dredging operations, were repaired at the expense of the canal, and the cost charged to dredging. The canal dredge *Ajax* is now 17 years old, and will soon have to be completely rebuilt. Dump boats "B" and "D" were entirely rebuilt and some improvements in their construction, dictated by experience, were effected. Several canal barges also received minor repairs.

*Boom below the lower lock.*—The boom was taken in October 26, 1891, and replaced April 10 and 11, 1893, by the snag boat *General Barnard*. It lay during the winter in the canal above the lower lock. During the past season two of the large mooring chains have been broken by the impact of rafts or other tows. These chains are of 1-inch iron, and seem to have no superabundance of strength. They will be replaced as soon as the water falls sufficiently to admit of drilling the holes for new fastenings.

The maneuvering winches were overhauled and heavier gears substituted where the old ones next the chain sheave had been found too light for the work required of them. In general the boom has answered its purpose excellently and has given but little trouble. There has been but one case of trouble with drift, and that not serious, notwithstanding the high water. It was painted one coat of mineral paint, the top rail being painted white.

*Machine shop at lower lock.*—The new brick machine shop authorized last year has been finished and was ready for occupancy January 1, 1893. Contractor F. L. Griffey pushed the work along notwithstanding the cold weather, and the machine tools were transferred from the old shop in the latter part of December, 1892. This new shop is 30 by 60 feet, two stories high, with large storage room above for the many patterns owned by the Government. It is well heated by exhaust steam from the engine, and is most convenient and comfortable. During the year there have been added to its equipment some much-needed tools, namely, one lathe, 18-inch swing, 8-foot bed; one twist-drill grinder, a set of planer centers, a large bench vise, and a portable drilling apparatus. A very large amount of necessary work was accomplished in the machine shop by the canal employés during the winter months in overhauling and repairing the canal machinery, as well as that of the large plant employed on river improvements in general. This work is repaid the canal in the use of the river improvement, dredges, and towboats, which at high water are able to assist in keeping the canal clear of deposit at a time when the stage of water is unfavorable for river works, but most profitable for dredging operations in the canal. Among the works accomplished in the shop may be mentioned: Rebuilding the capstan engine of the *Coal Bluff*; repairs to capstans of the *Vixen* and *Parke*; building a new 2¼-yard dipper for the *Phœnix*; rebuilding the supply pumps of the *Vixen*, *Stella*, *Iris*, and *Lucia*; building two drill carriages and the screws and machinery for operating the two steam drills of new drill boat No. 6; building a double capstan engine and capstan for drill boat; new packing rings for the main engines of the *Iris*, *Stella*, *Lucia*, and *Vixen*; remodeling the reversing gear of the steamer *Parke*, and much other miscellaneous work.

*Operating dry dock.*—The dock has been in constant and increasing use during the whole year. A new timber shed, 30 by 75 feet, for storing oak and valuable lumber, has been erected. A great deal of repair work has been carried on, both to canal dredges and towboats and to the floating plant belonging to the general river improvement. The table appended shows the boats docked. Very heavy repairs were made on the steamer *Coal Bluff* and the dredge *Vulcan*. The launch *Iris* was completely rebuilt. Six new office boats, 12 by 32 feet, were constructed, and one coal flat (No. 53) is almost finished. One new drill boat, 80 by 20, is well under way, and four new building boats have been begun. A large number of private boats have used the dock for slight repairs not requiring over two days to accomplish. The snag boat *General Barnard* was docked, and also the Mississippi River Commission steamer *Patrol* and survey boat *Illinois*.

The total receipts from dockage fees of private boats was $138.50.

*Dredging canal.*—A survey was made of the entire canal April 3 and 4, 1893, which showed great improvement, due to the radical dredging operations undertaken last fiscal year. The same work has been continued this season, but still a large amount of dredging remains.

Dredging was mostly carried on in the upper and lower levels of the canal. In October a shoal developed between the lower lock and the Keokuk and Hamilton bridge that gave considerable trouble. The *Phœnix* and *Iris* were employed about a week in its removal. This shoal appeared due to a log that had floated in, and which caused the formation of a sand bar.

During the fiscal year there has been removed as follows:

| | | |
|---|---|---|
| From the upper level | cubic yards | 64,530 |
| From the lower level | do | 47,281 |
| From below lower lock | do | 2,143 |
| Total | | 113,954 |

The cost of the dredging during the fiscal year, exclusive of general superintendence and office expenses and charges for use and deterioration of plant, was $4,901.43.

A table is added showing the comparative dredging operations since the opening of the canal. As will be seen, 1,000,000 cubic yards of excavation will shortly be reached, distributed over seventeen years. Part of this deposit was no doubt accumulated during the years of building the canal, but is more than offset by what remains undredged. This is at present an average of removal of nearly 60,000 cubic yards per annum, or about five months' steady work for the canal dredge with single crew, or working two shifts a little less than half that time.

*Changes due to the eight-hour law of August 1, 1892.*—In conformity with instructions, lock crews were arranged on an eight-hour basis June 18, 1893. The twelve-hour watch of these men up to that time was oppressive, and the night crew, especially, suffered. The change was very gratifying to the men and added only six to the lock force. As now divided, there are three watches of three men each at the three locks instead of four on the day watch and three on the night watch.

The dredge has been worked on the eight-hour system since April 1, 1893. It is too soon to estimate the difference in cost per cubic yard of dredging, but it will no doubt be appreciable.

During the past year I have been ably assisted by Mr. John R. Carpenter, acting superintendent, and Mr. O. S. Willey, clerk.

Very respectfully, your obedient servant,

M. MEIGS,
*U. S. Civil Engineer.*

Maj. A. MACKENZIE,
*Corps of Engineers, U. S. A.*

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## Z 5.

## PRELIMINARY EXAMINATION OF HAMBURG BAY, ON THE MISSISSIPPI RIVER, IN CALHOUN COUNTY, ILL.

[Printed in House Ex. Doc. No. 26, Fifty-second Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
*Washington, D. C., December 5, 1892.*

SIR: I have the honor to submit the accompanying copy of report dated November 7, 1892, by Maj. A. Mackenzie, Corps of Engineers, upon preliminary examination of Hamburg Bay, on the Mississippi River, in Calhoun County, Ill., made in compliance with provisions of the river and harbor act approved July 13, 1892.

From this report it appears that a survey of a portion of Hamburg Bay was made in 1884, and that an examination of the bars in the bay was made to comply with the provisions of the river and harbor act of 1886; also that some dredging was done near the mouth of the bay in 1886 and 1889.

Major Mackenzie states that all the beneficial results secured by former dredging have been obliterated by new deposits, but that the bay itself is a fine one and undoubtedly worthy of improvement by the General Government to an extent justified by the interest of the commerce and navigation concerned. The information now on hand and such additional surveys and examinations as can be made in connection with the improvement of the Mississippi River will permit at any time the means of preparing plans and estimates for the improvement of this locality.

These views meet with the concurrence of the Division Engineer, Col. O. M. Poe, Corps of Engineers, and of this office.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
*Brig. Gen., Chief of Engineers.*

Hon. S. B. ELKINS,
*Secretary of War.*

## REPORT OF MAJ. A. MACKENZIE, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
*Rock Island, Ill., November 7, 1892.*

GENERAL: The river and harbor act of July 13, 1892, provides for a preliminary examination of "Hamburg Bay, on the Mississippi River, in Calhoun County, Ill." This examination was assigned to me by letter of the Chief of Engineers dated July 14, 1892.

A survey of a portion of this bay was made under the direction of Maj. E. H. Ruffner, Corps of Engineers, in 1884.

The river and harbor act of August 5, 1886, under item for "Improving Mississippi River from Des Moines Rapids to the mouth of the Illinois River," provided for "removal of the bars at the mouth of * * * Hamburg Bay," and also provided for an examination or survey of "bars in Hamburg Bay."

The river and harbor act of August 11, 1888, under item for "Improving Mississippi River from Des Moines Rapids to the mouth of Illinois River," provided for "removing bars at the mouth of * * * Hamburg Bay, if, in the opinion of the Secretary of War, the same is deemed advisable in the interest of commerce and navigation."

Under date of January 17, 1887, Major Ruffner submitted a preliminary report upon the "bars in Hamburg Bay," from which the following extracts are given:

> Hamburg Bay is an outlet into the Mississippi of several drainage streams, which cover an area of perhaps 650 square miles. These streams, which would in many cases empty into the river direct, have been diverted by the levee known as the "Sny Levee" into a common drainage outlet through Hamburg Bay, the mouth of which is 12 miles below Clarksville and 31 above the mouth of the Illinois River. A railroad crosses the river at Louisiana, and below that road, in the angle between the Illinois and the Mississippi, is an area largely depending upon the rivers as the means communication.
>
> The shipping points of the vicinity in question are Hamburg, 2 miles below the mouth of the bay, and Bayville, 1¼ miles up the bay. When the stage of water permits there is a steamer, the *Bald Eagle*, which makes triweekly trips between St. Louis and Clarksville, calling at Bayville both ways. When the water is too low for her to run, the smaller steamer, *Dora*, takes her place in the trade. It is known that considerable quantities of produce are shipped by these boats, but I have not been able to get an exact, or even an approximate, amount of freight handled.
>
> Hamburg Bay is also used as an ice harbor at times to winter boats in, and this winter two of the largest boats on the river, the *Gem City* and the *Saint Paul*, besides the *Flying Eagle*, a smaller steamer, and two barges, are wintering there. These boats would not have gone there this year but for the dredging of a channel through the bar at the mouth of the bay this fall.
>
> The bars are two in number. The one at the mouth is now being dredged in accordance with the terms of the appropriation bill of 1886, and is not now an obstacle nor will be for a time at any rate. About a mile above the mouth is a second bar, which has only about 2 feet of water on it at low water, and which is a serious obstacle to the proper use of the bay.
>
> For the reasons given above, and supplemented by my knowledge of the fact that navigation interests of the locality are anxious that the bar should be removed, I have no hesitation in saying that I think the harbor is worthy of improvement.
>
> From information already at hand, however, from prior surveys, it will not be necessary to cause further surveys to be made.

No further report on this subject was made.

Some dredging was done under the direction of Major Ruffner near the mouth of Hamburg Bay in 1886 and 1889.

In August, 1892, the snag boat *General Barnard* went up into Hamburg Bay, and an examination of the channel depths was made, and during the same month a personal examination of the bay was made by me.

To determine the relation of this bay to the interests of commerce, circular letters were addressed, in August, 1892, to all parties who were known to be interested in the navigation of the bay. No replies have been received.

The report submitted by Major Ruffner in 1887 describes the bay, its commerce, and the character of the obstructions which prevent its being fully utilized as a harbor. The bay itself is a fine one, with deep water, and, if it could be entered at all stages of the river, would form a safe winter harbor; but near its mouth obstructive bars are formed by creeks, there being at most times not sufficient current in the bay to wash away such creek deposits. Some material is also probably brought into the bay near its mouth by sloughs which connect it with the Mississippi River.

All the beneficial results secured by former dredging have been obliterated by new deposits, and it is probable that to furnish relief by dredging such work must be repeated after each freshet in the creeks mentioned. It is possible a detailed survey or examination might show that the creeks can be diverted and their injurious effect on the channel of the bay removed.

This bay is undoubtedly worthy of improvement by the General Government to an extent justified by the interest of commerce and navigation interested; but it being impracticable for me to secure the details of such commerce and navigation, I can not determine what work should be recommended.

The information now at hand, and such additional surveys and examinations as can be made in connection with the improvement of the Mississippi River, will permit at any time the means of preparing plans and estimates for the improving of the channel at the mouth of Hamburg Bay, and no further special survey is recommended.

Very respectfully, your obedient servant,

A. MACKENZIE,
*Major, Corps of Engineers.*

Brig. Gen. THOMAS L. CASEY,
*Chief of Engineers, U. S. A.*

(Through Col. O. M. Poe, Corps of Engineers, Division Engineer, Northwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
*Detroit, Mich., November 11, 1892.*

Respectfully forwarded to the office of the Chief of Engineers.

I concur in the views of the district engineer.

O. M. POE,
*Colonel, Corps of Engineers,*
*Division Engineer, Northwest Division.*

## Z 6.

## PRELIMINARY EXAMINATION OF MISSISSIPPI RIVER, IOWA SIDE, FROM MOUTH OF IOWA RIVER TO BURLINGTON, TO DETERMINE THE BEST METHOD OF REMOVING THE BARS AND DEEPENING THE CHANNEL.

[Printed in House Ex. Doc. No. 88, Fifty-second Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
*Washington, D. C., December 5, 1892.*

SIR: The river and harbor act approved July 13, 1892, provided for a preliminary examination of Mississippi River, Iowa side, from mouth of Iowa River to Burlington, to determine the best method of removing the bars and deepening the channel.

Maj. A. Mackenzie, Corps of Engineers, the officer in charge of the improvement of the river from mouth of the Missouri to Minneapolis, in a report dated November 7, 1892, copy herewith, states that a "method of removing the bars and deepening the channel of the Mississippi River" was adopted in 1878, and has been successfully followed since that time; that the section of the Mississippi River referred to is worthy of improvement, and that work under the approved method mentioned has been in progress there for many years, and surveys of portions of the section are being made continually in connection with such work of general improvement. No further survey is required, and no special appropriations are needed for this work, it being practicable to allot such amounts as are necessary from the existing general appropriation for improving Mississippi River from mouth of the Missouri River to Minneapolis.

These views are concurred in by the division engineer and by this office.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
*Brig. Gen., Chief of Engineers.*

HON. S. B. ELKINS,
*Secretary of War.*

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## REPORT OF MAJ. A. MACKENZIE, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
*Rock Island, Ill., November 7, 1892.*

GENERAL: The river and harbor act of July 13, 1892, provides for a preliminary examination of the "Mississippi River, Iowa side, from mouth of Iowa River to Burlington, to determine the best method of removing the bars and deepening the channel." This preliminary examination was assigned to me by letter dated Office Chief of Engineers, July 14, 1892.

A "method of removing the bars and deepening the channel of the Mississippi River" was adopted in 1878, and has been successfully followed since that time. It consists in the construction of brush and stone dams, in the bed of the river, and shore protections, having for their object the closing of secondary channels and the building up of new banks for the purpose of reducing the river to a width proportionate to the amount of water discharged; and the protecting of the heads of islands and other caving banks, so as to maintain proper channel boundaries and prevent, as far as possible, the formation of new obstructions in the channel of the river.

The improvement of the section of the Mississippi River referred to, under such approved method, has been in progress for many years, and surveys of portions of the section are being continually made in connection with such work of general improvement.

Some portions of the Mississippi River between the mouth of the Iowa River and Burlington are, in their natural condition, very wide, divided by islands into numerous channels, and contain many sand bars. At a few localities rocks are found. Improvements have been so far undertaken at points where the natural condition resulted in the formation of obstructions, as at Keithsburg, Benton Island, Rush and Otter islands, and above Burlington. At all these points most satisfactory results have been secured, and during the last low-water season no material difficulties were met with by the interests of navigation in this section of the Mississippi River. Approved projects contemplate the construction of work at points named, and at other points where obstructions may be developed. Detailed examinations and close study of the river carried on through many years, and results secured by work already carried out, afford convincing proof that the method of removing bars and deepening now being followed is the correct one.

The section of the Mississippi River considered is worthy of improvement, but no survey is required beyond those constantly being made in connection with construction work. No special appropriations are needed for this work, it being practicable to allot such amounts as are necessary from the existing general appropriation for improving Mississippi River from the mouth of the Missouri to Minneapolis.

Very respectfully, your obedient servant,

A. MACKENZIE,
*Major, Corp of Engineers.*

Brig. Gen. THOMAS L. CASEY,
*Chief of Engineers, U. S. A.*

(Through Col. O. M. Poe, Corps of Engineers, Division Engineer, Northwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
*Detroit, Mich., November 11, 1892.*

Respectfully forwarded to the office of the Chief of Engineers.
I concur in the views of the district engineer.

O. M. POE,
*Colonel, Corps of Engineers,*
*Division Engineer, Northwest Division.*

## Z 7.

## PRELIMINARY EXAMINATION OF HARBOR AT MOLINE, ILL.

[Printed in House Ex. Doc. No. 30, Fifty-second Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
*Washington, D. C., December 5, 1892.*

SIR: The river and harbor act approved July 13, 1892, provided for a preliminary examination of the harbor at Moline, Ill. This examination has been made by Maj. A. Mackenzie, Corps of Engineers, and a report thereon submitted under date of November 7, 1892, a copy of which is herewith.

An examination of Moline City Harbor and report were also made by Maj. Mackenzie in 1888 to comply with the requirements of the river and harbor act of August 11, 1888. He now states that there have been but few changes in condition since that report was made, and those changes are not such as to alter the opinion formerly expressed, that the harbor is not worthy of improvement by the General Government after the manner proposed and desired by the city of Moline.

Col. O. M. Poe, Corps of Engineers, the Division Engineer, concurs with the district engineer, and the views of these officers are also held by this office.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
*Brig. Gen., Chief of Engineers.*

Hon. S. B. ELKINS,
*Secretary of War.*

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### REPORT OF MAJ. A. MACKENZIE, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
*Rock Island, Ill., November 7, 1892.*

GENERAL: The river and harbor act approved July 13, 1892, provides for a preliminary examination of "Harbor at Moline, Illinois." Such examination is assigned to me by letter dated Office Chief of Engineers, July 14, 1892.

The river and harbor act of August 11, 1888, provided for an examination of "Moline City Harbor, Illinois," with a view to determining whether or not such harbor was worthy of improvement by the General Government. Such examination was made by me, and reported on under date of December 7, 1888, which report is found in the Report of the Chief of Engineers for 1889, pp. 1777–1781. My conclusions were that under the conditions then existing, and considering cost, the harbor was not worthy of improvement by the General Government.

Since the former report was submitted the only conditions which have been changed are, that under the supervision of the Ordnance Department, U. S. Army, the channel cut in the rock bottom to permit a freer flow of water to the water-power pool, has been widened materially in its upper portion. This cut as it now exists, while having an elbow not favorable to interests of navigation, is nowhere less than 200 feet in width, and is used even at low stages of water by boats drawing 24 to 30 inches of water and carrying building rock, sand, and occasionally brick and tile, into Moline Harbor. Small-sized raft boats also have made use of the channel as far down as the Moline bridge.

It is understood that the channel and harbor desired by the city of Moline is now—as when my last report was submitted—one that will permit all classes of boats to come down, at all stages of the river, from the head of the water-power pool to the main shore above the Moline bridge, at a point set aside by the city as a public landing. While the rock excavation recently carried out under the direction of the commandant of the Rock Island Arsenal reduces somewhat the former estimate of cost, it still remains my opinion that the cost of work necessary for completing such a channel is not justified by the interests of navigation involved.

For further details concerning the work I would respectfully refer to my report of December 7, 1888. There have been but few changes in condition since that report was made, and such changes are not such as to alter the opinion formerly expressed, that the harbor is not worthy of improvement by the General Government after the manner proposed and desired by the city of Moline. And, so far as I am informed, it is the city only that has any material interest in the work desired.

Detailed surveys of the harbor were made in connection with "Development work in water-power pool at Rock Island Arsenal," and no further surveys are needed.

Very respectfully, your obedient servant,

A. MACKENZIE,
*Major, Corps of Engineers.*

Brig. Gen. THOMAS L. CASEY,
*Chief of Engineers, U. S. A.*

(Through Col. O. M. Poe, Corps of Engineers, Division Engineer, Northwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
*Detroit, Mich., November 11, 1892.*

Respectfully forwarded to the office of the Chief of Engineers.

I concur in the views of the district engineer.

O. M. POE,
*Colonel, Corps of Engineers,*
*Division Engineer Northwest Division*

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## Z 8.

### PRELIMINARY EXAMINATION OF MISSISSIPPI RIVER AT AND NEAR BELLEVUE, IOWA, WITH A VIEW TO SO REPAIRING AND FIXING DAM THAT FERRY CHANNEL WILL BE RESTORED.

[Printed in House Ex. Doc. No. 83, Fifty-second Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
*Washington, D. C., December 5, 1892.*

SIR: I have the honor to submit the accompanying copy of report, dated November 7, 1892, made by Maj. A. Mackenzie, Corps of Engineers, upon preliminary examination of Mississippi River at and near Bellevue, Iowa, with a view to so repairing and fixing dam that ferry channel will be restored, authorized by the river and harbor act approved July 13, 1892.

Maj. Mackenzie reports that in his opinion the Mississippi River in the locality of Bellevue is worthy of improvement, and the work of restoring the ferry channel by repairing and fixing the dam is a proper one, it being incidental to the work of channel improvement. No special survey of the locality is necessary, and no special appropriation is needed, appropriations being now available for the improvement of the Mississippi River between the mouth of the Missouri and Minneapolis which can properly be applied to the work on the dam when other work is carried out in the vicinity of Bellevue.

The Division Engineer, Col. O. M. Poe, Corps of Engineers, concurs in the views of Maj. Mackenzie; and it is the opinion of this office that the locality in question is worthy of improvement in the manner indicated.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
*Brig. Gen., Chief of Engineers.*

HON. S. B. ELKINS,
*Secretary of War.*

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## REPORT OF MAJ. A. MACKENZIE, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
*Rock Island, Ill., November 7, 1892.*

GENERAL: The river and harbor act of July 13, 1892, provides for a preliminary examination of the "Mississippi River at and near Bellevue, Iowa, with a view to so repairing and fixing dam that ferry channel will be restored." This examination was assigned to me by letter of the Chief of Engineers dated July 14, 1892.

A detailed examination of the locality was made by the crew of the snag boat in September, 1892.

The channel of the Mississippi River in front of Bellevue was formerly divided by an island (No. 248). Beyond this island, toward the main Illinois shore, are several sloughs forming other islands.

In 1878, in connection with the improvement of the low-water channel of the Mississippi River, a dam was built by the United States, behind Island 248, for the purpose of cutting off the channel to the left of the island. This dam served its purpose admirably, and materially improved a very troublesome crossing in front of Bellevue.

Previous to the construction of the dam above referred to, and for some time subsequently, the Bellevue ferryboat ran across the head of Island 248 through a cut-off made by the citizens, into Crooked Slough, and through the latter slough to the main Illinois shore. Within the past few years a large sand bar has been moving down along the left bank of the river, and it now at low stages obstructs the entrance to the cut-off, and materially interferes with the successful operation of the ferry.

It is claimed that the dam constructed by the Government behind Island 248 has caused the accumulation of sand referred to, and it is the desire of those representing the interests of Bellevue and its ferry that the dam be so raised as to permit its use as a causeway.

While it is very probable that the movement of the sand would have resulted in the obstruction of the channel and cut-off used by the ferry, even if the dam had not been built, and that the injury to the ferry interests can not be, by any direct evidence, charged to the work of the Government, it is a fact that the dam was built for the purpose of accumulating sand on the left bank, and, whether the existing sand bar is chargeable to the dam or to natural causes, it is quite certain that the dam will maintain the present condition and prevent such movement of sand as might result in a new ferry channel.

Under these conditions it appears proper that the dam be so repaired by the Government as to permit of the construction and maintenance by the ferry company of a causeway, which can be used at times when the stage of water prohibits the passage of the boat over the sand bars, to the main Illinois shore.

The repairing and raising of the dam may not be an absolute necessity in the interest of channel improvement at the present time, but such work can be properly considered as a part of a future plan for additional improvement work in the vicinity of Bellevue. * * *

As the work referred to may be considered a part of the general plan for improving the channel of the Mississippi River, and for the reasons given, I would respectfully report that, in my opinion, the Mississippi River in the locality of Bellevue is worthy of improvement, and the work of restoring the ferry channel by "repairing and fixing dam," being incidental to the work of channel improvement, is a proper one.

Appropriations which are now available for the improvement of the Mississippi River between the mouth of the Missouri and Minneapolis can be properly applied to the "repairing and fixing of dam" when other work of improvement is carried out in the vicinity of Bellevue. Such work will probably be undertaken under approved projects next year.

No special survey of the locality is necessary, and no special appropriation is needed for carrying on any work which may be deemed necessary.

Very respectfully, your obedient servant,

A. MACKENZIE,
*Major, Corps of Engineers.*

Brig. Gen. THOMAS L. CASEY,
*Chief of Engineers, U. S. A.*

(Through Col. O. M. Poe, Corps of Engineers, Division Engineer, Northwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
*Detroit, Mich., November 11, 1892.*

Respectfully forwarded to the office of the Chief of Engineers.

I concur in the views of the district engineer.

O. M. POE,
*Colonel, Corps of Engineers,*
*Division Engineer, Northwest Division.*

## Z 9.

## PRELIMINARY EXAMINATION OF LAKE PEPIN, WISCONSIN, WHETHER ADDITIONAL HARBORS OF REFUGE ARE NECESSARY, AND, IF NECESSARY, WHERE THE SAME SHOULD BE LOCATED.

[Printed in House Ex. Doc. No. 52, Fifty-second Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
*Washington, D. C. December 5, 1892.*

SIR: I have the honor to submit the accompanying copy of report dated November 7, 1892, by Maj. A. Mackenzie, Corps of Engineers, upon preliminary examination of Lake Pepin in the Mississippi River, as to whether additional harbors of refuge are necessary, and, if necessary, where the same should be located, made in accordance with provisions of the river and harbor act approved July 13, 1892.

Major Mackenzie is of the opinion that additional harbors of refuge on Lake Pepin are necessary, and that the matter is worthy of consideration by the General Government; but that one such harbor located on the Minnesota shore, near Kings Coulee, will for the present at least serve all purposes of navigation. He also states that no additional special surveys are required in advance of the preparation of plans and estimates of cost of the work, and that such plans and estimates can be prepared from information now at hand or attainable in connection with the general work of improving the Mississippi River.

These views are concurred in by the Division Engineer, Col. O. M. Poe, Corps of Engineers, and by this office.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
*Brig. Gen., Chief of Engineers.*

HON. S. B. ELKINS,
*Secretary of War.*

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### REPORT OF MAJ. A. MACKENZIE, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
*Rock Island, Ill., November 7, 1892.*

GENERAL: The river and harbor act of July 13, 1892, provides for a preliminary examination of "Lake Pepin, Wisconsin, whether additional harbors of refuge are necessary, and, if necessary, where the same should be located." This examination was assigned to me by letter of the Chief of Engineers dated July 14, 1892.

To ascertain the opinion of navigators, a circular letter was sent out by me to all lumber firms, and packet and towing companies, and to all masters and pilots of the Upper Mississippi River, asking for information as to necessity of additional harbors of refuge on Lake Pepin, and, if considered necessary, for their views as to location. In response to such letter one hundred or more replies have been received. Examination of the various localities suggested have been made by the crew of the snag boat.

A small number of the navigators consulted consider that the harbors now existing at Lake City on the Minnesota side, and at Stockholm on the Wisconsin side, are sufficient, and that no additional harbors are necessary; half a dozen recommend the establishment of a harbor on the Wisconsin side of the lake in the vicinity of North Pepin; thirty-five consider a harbor on the Minnesota shore in the vicinity of Kings Coulee most necessary, and thirty-seven favor construction of additional harbors on both sides of the lake.

The river and harbor act of March 3, 1881, required a "survey for harbors of refuge in Lake Pepin, at Stockholm, Wis., and Lake City, Minn." This survey was made by me and reported on under date of February 13, 1882, Report Chief of Engineers for 1882, pp. 1794–1797. From the report mentioned I quote the following, which explains the conditions existing on Lake Pepin, and gives an approximate idea of commerce interested:

> Lake Pepin is a wide stretch of the Mississippi River, about 20 miles in length, from 1¼ to 3 miles in width, and of an average depth of about 35 feet. There is little or no current. Lake City and Stockholm are situated about midway between its upper and lower ends, the former on the western shore, the latter on the eastern.
>
> Storms and high winds are very frequent in the lake during the season of navigation, and its surface becomes very rough in even a moderate gale.
>
> The boats used in navigating the Upper Mississippi, both for general passenger and freight business and for rafting logs and lumber, are necessarily, on account of shoal water in the river, of such light construction and small depth of hull that they are unfit for rough weather and waves, and are consequently subjected to frequent delays and occasional danger to life and property.
>
> On the western side there are three gravel points extending into the lake, which afford partial protection to boats and rafts in stormy weather, when they are able to reach their shelter.
>
> On the eastern side, which is generally a rocky shore, there is no safe landing place available during the prevalence of high northerly or southerly winds.
>
> The value of merchandise annually transported through the lake is variously estimated at from $250,000 to $500,000, besides about 150,000,000 feet of logs and lumber. There are no good landings or piers where freight can be conveniently shipped, and there also being so much risk the cost of transportation is greatly increased.
>
> The construction of a safe harbor at some middle point in the lake, as at Stockholm or Lake City, or both, would be of material benefit to the interest of navigation.
>
> (1) It would facilitate the loading and unloading of freight and diminish the risk of the same, thereby greatly lessening the cost of transportation; and,
>
> (2) It would afford a place of refuge for steamboats with or without tows, and rafts of logs and lumber when unavoidably caught in the lake in a storm. At present steamboats with rafts are often delayed for days at the head of the lake, being afraid to attempt the entire passage, which occupies from six to seven hours, when, were there a safe harbor midway, they could frequently take advantage of a lull in the gale and easily and safely make the halfway point.

The harbors proposed for Lake City and Stockholm were built and have served their purpose well.

It is possible that, considering passenger and freight packets only, which move rapidly through the lake, and which, under present conditions of harbors, will not be exposed to danger of sudden storms for more than one hour, additional harbors of refuge may not at the present time be a great necessity, though even for this class of boats they would at times be very useful, and would reduce the probabilities of accidents involving loss of life and property.

With boats towing rafts the case is somewhat different. Accidents to rafts on Lake Pepin are not common, but they do occur, and long waitings for conditions favorable for navigating some portions of the lake are very common. The most dangerous portion of the lake is between Lake City and Reeds Landing, a distance of about 10 miles. In this section of the lake no artificial or partial harbors are found, and boats with rafts after passing the Lake City Harbor must remain exposed to the dangers of sudden storms on the lake for several hours. All the accidents to rafts of which I have record have occurred in this section of the lake, and nearly all of such would undoubtedly have been prevented by an artificial harbor properly located.

I am of the opinion that additional harbors of refuge on Lake Pepin are necessary and worthy of consideration by the General Government.

While additional harbors of refuge on both sides of the lake would serve a useful purpose, it is my opinion that one located on the Minnesota shore, near Kings Coulee—which point is near the route of rafts and about halfway between Lake City and the foot of the lake—will, for the present at least, serve all purposes of navigation.

The construction of a harbor in the locality mentioned would be a matter of some difficulty, the depth of water being about 32 feet at low stage, and the exposure to the destructive action of ice being very great; but these difficulties were overcome at Lake City, where the same depth and conditions existed.

No additional special surveys are required in advance of the preparation of plans and estimates of cost of the work. Such plans and estimates can be prepared from information now at hand or obtainable in connection with the general work of improving the Mississippi River.

Very respectfully, your obedient servant,

A. MACKENZIE,
*Major, Corps of Engineers.*

Brig. Gen. THOMAS L. CASEY,
*Chief of Engineers, U. S. A.*

(Through Col. O. M. Poe, Corps of Engineers, Division Engineer, Northwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
*Detroit, Mich., November 11, 1892*

Respectfully forwarded to the office of the Chief of Engineers.

I concur in the views of the district engineer.

O. M. POE,
*Colonel, Corps of Engineers,*
*Division Engineer, Northwest Division.*

# APPENDIX A A.

## IMPROVEMENT OF MISSISSIPPI RIVER ABOVE FALLS OF ST. ANTHONY, MINNESOTA, OF RIVERS IN WISCONSIN AND MINNESOTA TRIBUTARY TO MISSISSIPPI RIVER, AND OF RED RIVER OF THE NORTH, MINNESOTA AND NORTH DAKOTA; GAUGING MISSISSIPPI RIVER AT ST. PAUL.

*REPORT OF MAJ. W. A. JONES, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1893, WITH OTHER DOCUMENTS RELATING TO THE WORKS.*

### IMPROVEMENTS.

1. Mississippi River above Falls of St. Anthony, Minnesota.
2. Reservoirs at headwaters of Mississippi River.
3. Chippewa River, including Yellow Banks, Wisconsin.
4. St. Croix River, Wisconsin and Minnesota.
5. Minnesota River, Minnesota.
6. Red River of the North, Minnesota and North Dakota.
7. Surveys for reservoirs at sources of Mississippi, St. Croix, Chippewa, and Wisconsin rivers.
8. Gauging Mississippi River at or near St. Paul, Minn.

UNITED STATES ENGINEER OFFICE,
*St. Paul, Minn., July 10, 1893.*

GENERAL: I have the honor to transmit herewith reports upon the works for improvement of rivers and harbors in my charge for fiscal year ending June 30, 1893.

* * * * * * *

Very respectfully, your obedient servant,

W. A. JONES,
*Major, Corps of Engineers.*

Brig. Gen. THOMAS L. CASEY,
*Chief of Engineers, U. S. A.*

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## A A 1.

### IMPROVEMENT OF MISSISSIPPI RIVER ABOVE FALLS OF ST. ANTHONY, MINNESOTA.

The present project, under which work has been carried on since and including 1880, is based upon a project for the improvement of 117 miles of the river, from Conradi Shoals to Grand Rapids, the latter the present head of steamboat navigation. The estimated cost, $54,127.50, is given in the report of February 8, 1875, upon part of the Mississippi routes to the seaboard, plan of improvement to afford 3 to 5 feet depth in the channel by removing snags, bowlders, and bars, and confining the low-water discharge to widths practicable for navigation by means of wing dams where necessary. In 1889 the estimate was increased to $63,000.

This same report (1875) estimated the cost of improvement of the river between the Falls of St. Anthony and St. Cloud at $144,667.50, the improvement of this section to afford 5 feet depth in the channel at low water between the Falls and St. Cloud by removal of sands, gravel, and bowlder bars, and the construction of wing dams. The sum of $20,000, appropriated by act of Congress approved August 14, 1876, was expended between these places. Prior to the rendition of the report and estimate of February 8, 1875, Congress had appropriated, by act approved June 23, 1874, the sum of $25,000 for improvement of the river above the Falls of St. Anthony, which was also expended in improving the channel between the falls and St. Cloud.

Steamboat navigation having discontinued between the falls and St. Cloud, a distance of 78 miles, the third appropriation, that of $15,000 by act of Congress approved June 14, 1880, was applied to the stretch (130¼ miles in length) of river between Aitkin and Grand Rapids, as have been all subsequent appropriations for improving the river above the Falls of St. Anthony, except the appropriation made by act of Congress approved September 19, 1890, which was applied to the stretch (185.4 miles in length) of river between Grand Rapids and Brainerd (this stretch included within the distance between the Rapids and Conradi Shoals).

Before work of improvement commenced under the present plan the stream between Grand Rapids and Aitkin was so obstructed by snags, bowlders, and leaning trees that at low and even high stages of water navigation was difficult and sometimes almost impossible for steamers drawing more than 3 feet of water.

The amount expended on present project to June 30, 1892, including outstanding liabilities, is $61,177.86. With this sum there had been produced a general depth in the improved channels of 3 feet at low water. A few snags, bowlders, and leaning trees offered some obstruction but did not seriously interfere with navigation.

Field work during the past fiscal year was performed between January 24 and February 13, 1893, in removing 130.25 cubic yards of bowlders from the channel in the vicinity of Pine Knoll, between Aitkin and Brainerd, resulting in freeing the channel over that section of all obstructions of any consequence.

There being no demand at present for navigation between Brainerd and Minneapolis, no further appropriation is now asked for. The time will come when this should be done. I will say, in conclusion, that this reach may be placed in excellent navigable condition at quite a reasonable expense.

Amount expended during the fiscal year ending June 30, 1893, including outstanding liabilities, $1,816.91.

The three completed reservoirs at the headwaters of the Mississippi River, above Grand Rapids, may be relied upon henceforth to provide sufficient water and depth for the steamboats on the river at and above Brainerd.

Last season two steamers with barges were engaged in freight and passenger transportation between Aitkin and Grand Rapids. During the winter of 1889–'90 the Duluth and Winnipeg Railroad Company constructed a line from Cloquet, a point on the St. Paul and Duluth Railroad, to La Prairie. They have since extended their line through and beyond Grand Rapids.

In 1889 my predecessor, Maj. C. J. Allen, reported:

> The comparative tables of commercial statistics herewith show that in 1880, the year in which the work of improvement between Aitkin and Grand Rapids commenced, there was but one steamer (with its barges) plying between those points, and that, though the amount of freight transported that year by steamer was unusually large, the freight rates were from 75 cents to $1 per 100 pounds, while in 1883, 1884, 1885, and 1886 the rates were reduced to 20 to 40 cents per 100 pounds. The last-named figures, obtained in 1886, at which time there were three steamboats engaged in freighting and carrying passengers between Aitkin and Grand Rapids. The country bordering the river north of Aitkin is becoming more and more settled, and there is no doubt that the improvement of the river already affected by the United States Government has largely contributed to the increase in settlement.

This work is in the collection district of Minnesota, of which St. Paul is the port of entry and St. Vincent a support. Collections for the year ending December 31, 1892, $424,177.40; value of domestic exports for same period, $282,736.

*Abstract of appropriations.*

| | |
|---|---|
| By act approved— | |
| June 23, 1874 | $25,000 |
| August 14, 1876 | 20,000 |
| June 14, 1880 | 15,000 |
| March 3, 1881 | 10,000 |
| By act passed August 2, 1882 | 10,000 |
| By act of August 11, 1888 | 10,000 |
| By act approved September 19, 1890 | 18,000 |
| Total | 108,000 |

### *Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $1,843.06 |
| June 30, 1893, amount expended during fiscal year | 1,827.48 |
| July 1, 1893, balance unexpended | 15.58 |
| July 1, 1893, outstanding liabilities | 10.35 |
| July 1, 1893, balance available | 5.23 |

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## COMMERCIAL STATISTICS.

*Comparative statement of steamboat business on the Mississippi River between Aitkin and Grand Rapids, 1880–1892, inclusive.*

| Year. | Steamboats. | Freight carried (general merchandise). | Passengers. | Year. | Steamboats. | Freight carried (general merchandise). | Passengers. |
|---|---|---|---|---|---|---|---|
| | | *Tons.* | | | | *Tons.* | |
| 1880 | 1 | 3,926 | 1,000 | 1887 | 3 | 1,855 | 2,884 |
| 1881 | 1 | 1,100 | 1,540 | 1888 | 3 | 2,650 | 2,860 |
| 1882 | 2 | 1,513 | 1,764 | 1889 | 2 | 3,500 | 5,250 |
| 1883 | 2 | 1,400 | 1,100 | 1890* | 1 | 1,606 | 1,253 |
| 1884 | 2 | 8,000 | 1,346 | 1891* | †2 | 1,500 | 1,000 |
| 1885 | 2 | 2,500 | 2,400 | 1892* | †2 | 1,250 | 3,000 |
| 1886 | 3 | 1,500 | 3,500 | | | | |

* Amount of navigation and commerce 1890, 1891, and 1892, approximate.

† Tonnage of steamboats, 140 and 185 tons, respectively.

*Comparative statement of loose logs run on the Mississippi River above the Falls of St. Anthony.*

| Year. | Loose logs run. | Year. | Loose logs run. |
|---|---|---|---|
| | *Feet B. M.* | | *Feet B. M.* |
| 1880 | 226,000,000 | 1887 | *265,000,000 |
| 1881 | 238,000,000 | 1888 | *265,000,000 |
| 1882 | 285,000,000 | 1889 | 288,000,000 |
| 1883 | 420,000,000 | 1890 | 325,069,280 |
| 1884 | 367,000,000 | 1891 | 425,716,970 |
| 1885 | 317,993,000 | 1892 | *520,000,000 |
| 1886 | 282,600,000 | | |

* Approximate.

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## A A 2.

## RESERVOIRS AT HEADWATERS OF MISSISSIPPI RIVER.

The reservoir project is the outcome of surveys and examinations in 1869, 1874, 1878, and 1879, the results of which are published in appendixes to various annual reports of the Chief of Engineers. The résumé of the subject is given in the Report of the Board of Engineers, printed in Appendix AA to the Annual Report of the Chief of Engineers for 1887.

From the results of the surveys and examinations just noted and further examinations in 1880, the first cost of constructing 41 reservoir dams in Minnesota and Wisconsin was placed at $1,809,083, exclusive of that of land damages, which could not be given in advance. (See p. 1871, Appendix W, to the Report of the Chief of Engineers for 1881.)

The project for this improvement was inaugurated in 1880 by an appropriation for the construction of a reservoir dam at Lake Winnibigoshish, made by act of Congress approved June 14, that year. For the reasons given in the Annual Report for 1886 the work of construction was commenced and has been continued in Minnesota.

The project has for its object the construction and maintenance of reservoirs at the headwaters of the Mississippi River, in the State of Minnesota, for the purpose of collecting the surplus water, principally from the precipitation of winter, spring, and early summer, to be systematically released so as to benefit navigation upon the Mississippi River below the dams and as far down as Lake Pepin. Reduction of heights of floods in localities immediately below the dams is expected to obtain to some extent, but control of extended floods or freshets is not expected.

There are four completed reservoirs, viz:

At Lake Winnibigoshish, completed in 1883-'84; capacity, 45,800,000,000 cubic feet.

At Leech Lake, completed in 1884; capacity, 30,000,000,000 cubic feet.

At Pokegama Falls, completed in 1884; lift of dam increased in 1889; capacity, 4,700,000,000 cubic feet.

At Pine River, completed in 1886; capacity, 7,500,000,000 cubic feet.

Rules and regulations to control the use and administration of the reservoirs were formulated and approved by the Secretary of War February 21, 1889, as authorized by the river and harbor act of August

11, 1888. Gaugings of the Mississippi River at St. Paul, to determine the effects of reservoir water, have been made to a limited extent during the past four years; they form the subject of a separate report.

During May and June, 1891, men and materials for constructing a fifth reservoir at Sandy Lake were assembled and the work of construction soon after commenced. The original plans for this dam were similar to those of the four dams previously constructed, but adapted to the conditions at Sandy Lake.

The operation of the dam at Sandy Lake involves a peculiar feature. The dam has for its object the storing of water, the release of the same for navigation purposes, and the passing of log drives, which the interposition of an obstruction in the navigable waterway necessitates.

When the discharge from Pokegama Reservoir is sufficient to raise the level of the water in the Mississippi River just below the dam higher than the level of the water in the reservoir, the conditions of head and pressure on the dam will be reversed.

The river and harbor act of Congress, approved July 13, 1892, appropriated "for care and maintenance of reservoirs at the headwaters of the Mississippi River, $60,000 of which $30,000 may be expended for the construction of a navigable pass through Sandy Lake Dam."

This provision delayed the completion of the dam. The portion, about one-half the length, that was not affected by the change was completed in the fall of 1892. An outline drawing of the navigable pass was submitted to the Chief of Engineers August 8, 1892, for approval. The plan showed a navigable pass 40 by 160 feet closed at both ends by improved bear-trap gates designed to act as an old style bear trap when the head is on the reverse or river side of dam. The specific gravity of the gates was to be slightly greater than 1 to enable them to sink in still water. To raise the gates in still water, air bags were introduced under the leaves which, when inflated with air, reduced the specific gravity to less than 1.

The air bags would be kept inflated until sufficient head (2 to 4 inches) had been collected to operate the gate. When operated as a lock gate the upper pool weir will be raised to the surface by the air bags.

The air bags will be made of canvas covered on both sides with pure rubber. Responsible firms will guarantee them for ten years.

This form of weir is suitable for use as a lock gate under widely varied conditions. Its length is only limited by the valve capacity for filling it in a reasonable length of time. and I see no reason why it could not be designed to carry a head of 50 feet or more. It is covered by patents to several parties in the United States. The only auxiliary power required for operating is a hand air pump and a reservoir or accumulator.

The plans were referred, by the Chief of Engineers, September 26, 1892, to a board of engineers, consisting of Maj. Amos Stickney, Maj. Alexander Mackenzie, and Capt. W. L. Marshall.

The board recommended the use of a direct hoist in addition to the air bags, and called for more detailed drawings, together with a working model. Full plans were developed and transmitted to the president of the board April 6, 1893. The model was also made. The plans were approved by the board and by the Chief of Engineers.

The work of construction is now in progress.

Amount expended upon this work, including examination at proposed dam sites, hydrological observations, land damages, amounts paid to commissioners in attempted settlement of awards to Indians, and care and maintenance of the works to the close of the fiscal year ending June 30, 1892, $684,042.23.

*Operations during the past fiscal year.*—Operating completed reservoirs, continuing construction of Sandy Lake Dam, building telephone line from Sandy Lake Dam to McGregor, Minn., a distance of 13.2 miles, building jam piers, and repairing gates at Pokegama Falls Dam. The jam piers are intended to create a controlled log jam at a safe distance above the dam, in order to protect the same in time of flood.

*Telephone line and jam piers.*—During the winter of 1892–'93 a small party of about 12 men, made up from the Sandy Lake force, was kept in the field. They lived in ordinary tents, and during the severest winter on record completely constructed a telephone line 13.2 miles long, from Sandy Lake to the Northern Pacific Railroad at McGregor, Minn., at the same time opening a wagon road along the line, through country that had been considered impassible on account of extensive swamps and floating bog. The mean monthly temperature was about 6° below zero, and minimum temperatures of from 40° to 50° below zero were common.

It was intended to construct a telephone line from the Duluth and Winnepeg Railroad near Winnibigoshish Dam to Leech Lake Dam, but upon authoritative information that a railroad line would soon be constructed passing the latter point, the matter was deferred; such a road would render the telephone unnecessary.

On March 24, 1893, this party was moved by rail to Pokegama Dam. A great increase in the logging business above the reservoir made it necessary to do something to hold large masses of logs away from the dam during floods and heavy discharges. The simple booms first constructed for this purpose could no longer be relied upon to protect the dam. A great mass of logs coming upon the dam would prevent the free manipulation of the gates and seriously imperil the structure. A site was selected about 2,500 feet above the dam and the device known to lumbermen as jam piers was introduced. These piers create a controllable jam of logs that will stand against any probable pressure. The party had these piers completed early in April.

Discharges from this dam are controlled by ordinary slide valves 4 feet by 5 feet, placed upon the floor. When the reservoir is nearly full the pressure on these valves makes it very difficult to handle them, even with the power gearing at each valve. Advantage was taken of the presence of this party to thoroughly examine the woodwork of the dam and also to place each 4 feet by 5 feet valve upon roller bearings to reduce the friction and make them handle easily. The winter operations of this party have been economical, creditable, and quite notable. During the early winter they were detached and operated upon the Mississippi River below Aitken, removing a great lot of scattered bowlders which obstructed navigation and which would have been very expensive as an open river operation.

Amount expended during fiscal year ending June 30, 1893, including outstanding liabilities, $43,757.44

The beneficial effects resulting in previous years from the operation of the completed reservoirs have been maintained.

The board of engineers, in their report dated May 24, 1887, and printed on pp. 1681–1698, Annual Report of the Chief of Engineers, 1887, express this opinion:

> As far down as the mouth of the first considerable tributary, the St. Croix, it is therefore not unreasonable to suppose that navigation may be benefited nearly in proportion to the effect upon the St. Paul gauge, *i. e.*, from 1 foot to 18 inches of low-water stages.

My predecessor, in his annual reports for the years 1887, 1888, and 1889, has stated:

> From such observations as means admitted of in 1885 and 1886, and stated in my reports of December 18, 1885, and November 5, 1886, both of which are here respectfully referred to, it appeared that when the river stood at 2 feet on the U. S. Signal Service gauge at St. Paul, the effect of every 100 cubic feet per second of water added to the river and steadily maintained was equivalent to increasing the depth one-tenth of a foot. As the river rises the depth effect of each 100 cubic feet of water decreases somewhat. It appears, however, from examinations in 1885 and 1886, that the effect of the liberated water from the four reservoirs was the addition of 1 foot and upwards to the depth at St. Paul, during the dry periods of those years, the additional depth being due to elevation of water surface as well as to additional scour.
>
> (See Appendix A A, Annual Report, 1887.)
>
> The benefit of the reservoir volume extended over some 425 [390] miles of river below Grand Rapids, the rapids being 388 [353] miles by river above St. Paul. Of the 425 [390] miles 200 [165] are navigated by steamers.
>
> The increase in channel depth at St. Paul, due to the release of the stored-up water, undoubtedly averaged, for the 86 days, 1 foot to 1¼ feet. (See Appendix Z, Annual Report, 1888.)
>
> The increase in channel, depth at St. Paul, due to the reservoir water, undoubtedly averaged 1 foot during the low-water season of 1888. (See Appendix B B, Annual Report, 1889).

The effect of the reservoirs on the navigable depth of water in the channel of the Mississippi River above the Falls of St. Anthony is not as conclusively shown as it could be. A series of hydrological and meteorological observations on the Mississippi and the principal tributaries above St. Paul, extending over a period of several years, would furnish information not only of great practical value in the operations of the reservoirs, but would also be of scientific value in connection with the loss of river water by evaporation and filtration and in the progression (and even dispersion) of a flood wave. A commencement in this direction has been made by the provision for gaugings at or near St. Paul, but the money availiable for the purpose is inadequate for thorough work, and is only applicable near St. Paul. It is estimated that the sum of $15,000 per annum can be profitably expended in hydrological and meteorological investigation, during a period of four years.

These dams have been created for impounding enormous bodies of water and releasing the same under control. The water is released through sluices which are opened or closed by operating devices. The operating portion of each is made of wood. This wood is subject to decay, and from this time on expensive repairs are likely to be called for at any time. It is impossible to foresee the full extent of such repairs in time to make an estimate for funds in the next succeeding Annual Report and thereafter wait the chances of an appropriation during one or more years. Grave liability would arise for losing the dams, with an attendant loss of life and property below them. It is, therefore, recommended that the reservoir system be placed under the operation of the statute which provides a permanent appropriation for the care, operation, and maintenance of completed structures which benefit commerce and navigation.

In this connection it is to be noted that no river and harbor appropriation was made for the year ending June 30, 1894, and consequently no provision for the maintenance of these reservoirs was made. Had it not been for an adventitious acquisition of funds from an unexpected source—the reversion of $15,663.17, which had been supposed to be paid for Indian claim damages—there would have been a very serious state of affairs. Without watchmen these great reservoirs would become a menace to life and property instead of a benefit to commerce and navigation.

The sum of $82,000 can be profitably expended during the two years ending June 30, 1896, as follows:

| | |
|---|---|
| Completion of navigable pass in Sandy Lake Dam | $20,000 |
| Operation and maintenance of the five completed reservoirs two years, at $16,000 per year | 32,000 |
| Hydrological and meteorological investigations two years, at $15,000 per year | 30,000 |
| Total | 82,000 |

For commerce benefited by the reservoirs reference must be made to the commercial statistics of the Mississippi River.

For valuable assistance in work upon and management of the reservoirs I am greatly indebted to Mr. Archibald Johnson, assistant engineer.

*Abstract of appropriations.*

| | |
|---|---|
| By act— | |
| Approved June 14, 1880 | $75,000.00 |
| Approved March 3, 1881 | 150,000.00 |
| Passed August 2, 1882 | 300,000.00 |
| Approved July 5, 1884 | 60,000.00 |
| Approved August 5, 1886 | 37,500.00 |
| Of August 11, 1888 | 12,000.00 |
| Approved September 19, 1890 | 80,000.00 |
| Approved July 13, 1892 | 60,000.00 |
| Total | 774,500.00 |
| Allotment per letter from office Chief of Engineers— | |
| November 9, 1881 | 1,572.15 |
| January 20, 1882 | 176.00 |
| January 18, 1888 | 643.85 |
| May 11, 1888 | 8.60 |
| Expenses of commissioners in attempted settlement of awards to Indians | 333.73 |
| Allotted and expended by officer in charge for meteorological observations, borings, examinations, etc., at proposed dam sites, letter from office Chief of Engineers, May 27, 1881 | 7,500.00 |
| Expended by the officer in charge in connection with the building and operating of five reservoir dams to June 30, 1893, including outstanding liabilities | 717,565.34 |
| Total allotted and expended to June 30, 1893, including outstanding liabilities | 727,799.67 |
| Estimated cost of the system (omitting that of land, etc., damages) | 1,809,083.50 |
| Amounts appropriated | 774,500.00 |
| Remaining to be appropriated | 1,034,583.50 |

*Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $39,781.61 |
| Amount appropriated by act approved July 13, 1892 | 60,000.00 |
| | 99,781.61 |
| June 30, 1893, amount expended during fiscal year | 44,231.44 |
| July 1, 1893, balance unexpended | 55,550.17 |
| July 1, 1893, outstanding liabilities | 8,849.84 |
| July 1, 1893, balance available | 46,700.33 |
| Amount (estimated) required for completion of existing project | 1,034,683.50 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895 | 51,000.00 |
| Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893. | |

## REPORT OF BOARD OF ENGINEERS UPON CONSTRUCTION OF NAVIGABLE PASS THROUGH SANDY LAKE DAM, MINNESOTA, ON THE MISSISSIPPI RIVER.

ST. PAUL, MINN., *May 15, 1893.*

GENERAL: The board of engineers constituted by paragraph 1, Special Orders No. 46, headquarters Corps of Engineers, September 26, 1892, to consider and report upon a project for the construction of a navigable pass through the Sandy Lake Dam, have the honor to submit their final report. The board first met at St. Paul on October 28, 1892, and submitted a preliminary report as follows:

ST. PAUL, MINN., *October 29, 1892.*

GENERAL: The board of engineers constituted by Special Orders No. 46, paragraph 1, Headquarters, Corps of Engineers, U. S. Army, dated Washington, D. C., September 26, 1892, have the honor to submit the following preliminary report:

The board met at St. Paul, Minn., October 28, 1892, and during that and the following day examined and considered the plans submitted by Maj. W. A. Jones, Corps of Engineers, for the proposed navigable pass through Sandy Lake Dam, Minnesota. The duties of the various members of the board rendered it expedient to meet at an earlier date. The only plans presented for the consideration of the board were the blue prints forwarded to them by the Chief of Engineers with the project of Major Jones. These plans are not complete in detail, and, as stated in Major Jones's letter, it was intended to modify them by reducing the height of the crib work and to lower the floor of the navigable pass. In general terms the project of Major Jones is to construct a lock to be used as a passageway through the Sandy Lake Dam, the chamber walls of the lock to be of crib work, the floor of timber, and the gates a modified form of bear-trap; the filling and emptying of the lock to be accomplished by lowering the gates sufficiently to allow the water to pass over them. From the information received in Major Jones's office, and the examination of models of gates somewhat similar to those which it is proposed to use, the board were sufficiently informed for a consideration of the proposed structure and method of operating. With regard to the proposed lock chamber, walls, floor, etc., there is nothing peculiar, but the gates are of peculiar construction, and are intended for peculiar conditions, as they are to be used with the head of water sometimes, on one side and sometimes on the other. They are what might be called Lang's modification of the Parker gate (which is a modification of the ordinary bear trap), with an additional feature in the introduction of air bags which can be inflated or collapsed at will. It is proposed to make the gates of sufficient weight to fall and remain down when there is no head of water and the air bags are collapsed, and yet light enough to rise so that the upper edge of one leaf shall come above water surface when the air bags are inflated. It is understood that the air bags are to be brought into use when it is necessary to close the pass for the collection of water in the lake, for lifting the gates when the pass is operated as a lock and the gates must rise in dead water, and when it is necessary to raise a gate after it falls or keep it up when the head of water changes from one side to the other.

To close the pass for the collection of water a gate would have to be raised without a head of water, perhaps two or three times in a year, and as soon as a few inches of head was obtained the pressure of water would hold the gate up. The use of the pass as a lock would, it is stated, be of rare occurrence, perhaps three or four times in a year, generally in the spring.

The head of water against a gate would generally be on the lake side, the reversing of the head occurring only in the case of a low lake at the time when the reservoirs farther up the Mississippi River were opened and it would be desirable to keep their water from flowing out of the Mississippi River into Sandy Lake. When the water from the Mississippi River side rises higher than 5 feet above the proposed lock floor it could be permitted to flow into the lake without detriment to the river.

The necessity, then, for raising and holding up the gates, by some method other than that provided by the pressure from a head of water that would usually exist, would be of infrequent occurrence.

The Lang gate is, the board are informed, in highly successful operation at various places, notably in a dam at Nevers, Wis., on the St. Croix River, where there are several of these gates, the largest covering an opening 80 feet wide, with a head of water of 16 feet. This was built in the winter of 1889–'90. In operating these gates the inlet and outlet valves for filling and emptying the gate chamber are connected and are reciprocating, so that the motion of opening closes the other, and *vice versa*. By setting the valves properly the pressure under the leaves can be so regulated as to hold the gate in any desired position. This feature makes it feasible to fill or empty a lock chamber by the flow over the gate. If the gate is made heavy enough to fall in dead water, that is, with the water standing at the same level on both sides, it is evident that some method must be provided for raising it and holding it up until sufficient head accumulates to make the upward pressure under the leaves greater than the downward pressure above the leaves. For this Major Jones proposes to use air bags fastened to the under sides of the leaves, into which air can be forced, thus providing an upward pressure equal to the difference in the weight of the air and an equal volume of water, the air to remain in the bags until the necessary head of water for holding the gate up is obtained. The board was not informed exactly as to how these bags were to be made and of what material. The general idea, however, was that the bags when inflated should be cyclindrical in form and that they should be made of some strong water-proofed cloth. In using the gates for a reversed head, the main leaves would rise and fall as in an ordinary bear trap, but as these leaves are of about equal length the use of the air bags or other contrivance would probably always be necessary to lift them and keep them up. It would seem to be better to have the main leaf on the lake side of the gates, which would be the lower leaf when the head was reversed longer than the other one.

Upon a full consideration of the subject the board came to the following conclusions:

That in view of the small amount of money available the form of lock chamber proposed by Major Jones is judicious.

That the form of gates proposed is feasible, and could probably be operated satisfactorily as long as the air bags with the necessary connections remained in perfect order; but the board have serious doubts concerning the practicability of making air bags of flexible material and air-tight movable connections that would be under water and remain in perfect working order for any considerable length of time. As the air bags would be brought into service only occasionally, and perhaps at long intervals of time, the board are of the opinion that the work of the air bags—that, is the occasional lifting and holding up of the gates—would be better performed, and with more certainty, by some simple device for direct application of power, such as chains fastened to the upper leaves of the gates and led up to capstans on top of the walls. The weight of the gates could be so regulated as to require but little power to lift them, for they could be made of pine timber, with just enough iron to cause them to sink, and if necessary counterweighted; and they could be made to stand up under pressure from a reversed head by arranging the main leaves like those of an ordinary bear trap—that is, with the under leaf longer than the upper one. The application of this form of gate to a lock is unique, and is considered well worth a trial, but before definitely recommending its adoption the board would respectfully make the following suggestions: That Major Jones be requested to have a working model of a gate made of convenient size, say to close an opening 12 inches in width and to lift from 6 to 10 inches, the gate to be of the form proposed by him, but without the air bags and with the under main leaf longer than the upper one, as in an ordinary bear trap, and with lifting chains carried up to a capstan or drum on the wall; and that in order to permit the board to submit detailed plans and estimates for such constructions as it may recommend for the navigable pass, as required by their instructions, Major Jones also be requested to prepare full plans of the structures in accordance with his project as modified by the proposed change in the gates.

Respectfully submitted.

AMOS STICKNEY,
*Major of Engineers.*
A. MACKENZIE,
*Major of Engineers.*
W. L. MARSHALL,
*Captain of Engineers.*

Brig. Gen. THOMAS L. CASEY,
*Chief of Engineers, U. S. A.*

On May 15 the board again met at St. Paul, and the plans of the lock and the working of a model of a gate were exhibited by Maj. W. A. Jones, Corps of Engineers.

The working of the gate with the head of water first on one side and then on the other appeared to be satisfactory and entirely feasible for a gate of full size, and the construction seems to meet the peculiar conditions under which the lock would be operated.

In an indorsement upon the preliminary report of the board, Major Jones suggested the propriety of equipping the gates with the air bags originally proposed, in addition to the capstans recommended by the

Board for raising the gates when there was not sufficient head of water. This, having been forwarded to the board for their information, was taken into consideration and reported upon as follows:

UNITED STATES ENGINEER OFFICE,
*Cincinnati, Ohio, January 16, 1893.*

GENERAL: In a preliminary report, dated October 29, 1892, presented by the board of engineers constituted to consider plans for navigable pass through Sandy Lake Dam, Minnesota, it was recommended that the plan of using air bags, as proposed by Major Jones, for hoisting gates be modified. An indorsement on such preliminary report by Major Jones, dated U. S. Engineer Office, St. Paul, December 23, 1892, and referred to the senior member of the board for his information, by indorsement dated Office Chief of Engineers, January 9, 1893, while approving of the modifications proposed, suggests that the use of air bags be adhered to as an auxiliary to the plan recommended by the board.

The board sees no objection to the double appliance for moving the gates, and, the additional cost not being great, it is willing to approve of the use of the air bags as an auxiliary power. If they remain in good condition for a considerable length of time, as is anticipated by Major Jones, their operation will probably be satisfactory; and if they prove not sufficiently durable, as is feared by the board, the simple arrangement recommended will be available and can be used.

Very respectfully, your obedient servants,

AMOS STICKNEY,
*Major, Corps of Engineers.*
A. MACKENZIE,
*Major, Corps of Engineers.*
W. L. MARSHALL,
*Captain, Corps of Engineers.*

Brig. Gen. THOMAS L. CASEY,
*Chief of Engineers, U. S. A.*

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The board would now respectfully recommend the approval of the plans* submitted herewith, and present the following estimate of cost:

| | | |
|---|---|---|
| 652,808 feet B. M. of grillage and superstructure, at $33 | | $21,542.66 |
| 56,112 feet B. M. of pine sheeting, at $55 | | 3,086.16 |
| 35,712 feet B. M. oak triple lap sheeting, at $66 | | 2,356.99 |
| 1,130 round piles, at $6 | | 6,780.00 |
| 3,600 cubic yards excavation, at 60 cents | | 2,160.00 |
| 3,600 cubic yards filling, at 40 cents | | 1,440.00 |
| 3,458 cubic yards rock filling, at $1.20 | | 4,149.60 |
| 105 cubic yards concrete, at $15 | | 1,575.00 |
| 4 air bags | | 550.00 |
| 2 air pumps | | 250.00 |
| 23,743 pounds finished weight of irons, Nos. 1, 2, 3, 4, 5, 6, 7, 8, 9, at 15 cents | | 3,561.45 |
| 6,256 pounds chain, at 10 cents | | 625.60 |
| 4 capstans with sheaves and ropes | | 560.00 |
| | | 48,637.46 |
| Value of material on hand: | | |
| 314,668 feet B. M. at $15 | $4,720.02 | |
| 5,408 feet B. M. oak at $25 | 135.20 | |
| 756 round piles, at $1 | 756.00 | |
| | | 5,611.22 |
| Total | | 43,026.24 |

Respectfully submitted.

AMOS STICKNEY,
*Major of Engineers.*
A. MACKENZIE,
*Major of Engineers.*
W. L. MARSHALL,
*Captain of Engineers.*

Brig. Gen. THOMAS L. CASEY,
*Chief of Engineers, U. S. A.*

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* Drawings not printed.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
*June 30, 1893.*

Approved.

THOS. LINCOLN CASEY,
*Brig. Gen., Chief of Engineers.*

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## A A 3.

### IMPROVEMENT OF CHIPPEWA RIVER, INCLUDING YELLOW BANKS, WISCONSIN.

The plan for improvement of the Chippewa River consists in revetment of caving bends and construction of dams and jetties from Eau Claire to the confluence of the stream with the Mississippi River, a distance of 57 miles, to confine the low-water volume to a channel of nearly uniform width and depth. The general plan for improvement was adopted in 1877, and the work has been carried on in accordance with it, varying, however, more or less as to location and extent of dams, jetties, etc.

The object of the protection of the Yellow Banks is to prevent erosion of the high sand bluffs or banks bordering the Chippewa River at a number of points below Eau Claire, and thereby to relieve the channels of that river and of the Mississippi below the junction of the two streams from the masses of sand contributed by those banks. The plan for protection consists in a revetment of piling and fascines, the latter to be crowned with rock.

The examination of the river upon which the plan and estimate were based was made in 1874. The report, dated January 30, 1875, of this examination is printed in Part I, Appendix to the Annual Report of the Chief of Engineers, pp. 375–380. In that report the estimate of the cost of improvement, including protecting the Yellow Banks, was $139,892.50.

The first appropriation for improving the Chippewa River was made in 1876 and the first for the protection of the Yellow Banks was made in 1882. These were regarded as separate and distinct works until the act of Congress of August 11, 1888, appropriated for the improvement of the Chippewa River, including the Yellow Banks in said river, Wisconsin, continuing improvement, $10,000.

The estimated cost, including all expenditure since 1876, for channel improvement of the river, as revised by my predecessor in 1888 (see pp. 1543, 1544, Annual Report for 1888), was placed at $176,487.72. The cost of protecting the Yellow Banks, as revised by the same officer in 1883 (see p. 1443, Annual Report for 1883), was estimated at $96,000, making the total cost for channel improvement and the protection of the Yellow Banks $272,487.72.

Before the improvement commenced the depth on the bars at low water seldom exceeded 18 inches and the crossing at the mouth of the river was extremely difficult at that stage, owing to the volume of the river joining the Mississippi through a number of channels of insufficient depth. Frequently the depth of water on the bar at the mouth of the river was but 10 or 12 inches.

The work of improvement to June 30, 1891, has provided a permanent channel 3 feet in depth over the bar at the mouth of the river and materially increased the depths over the Durand, Plum Island, Plum Island Flats, Battle Island, Wacouta Island, and Flower Pot Island bars, besides straightening a difficult piece of river at the Madison Street Bridge in Eau Claire, and the stoppage of a dangerous cut-off at Dead Lake. Where the improvements have been completed the channels are 3 feet or more in depth. The channel improvements have effected a reduction of 10 cents per thousand in the cost of running rafted lumber from Eau Claire to the mouth of the river.

No work of consequence has been done at the Yellow Banks since 1883. At that time revetments of the banks had been accomplished as follows:

At Waubeek Bank, 2,989 feet long, protection completed.

At Rumseys Bank, 4,500 feet long, piles all driven and 1,850 linear feet of protection completed.

At Mary Dean Bank, 6,900 feet long, piles have been driven for 625 linear feet and 139 feet of the protection completed.

Total expended from commencement of operation in 1877 to June 30, 1892, including outstanding liabilities, $165,574.78.

*Operations during the past fiscal year.*—Active construction operations were practically confined to the winter of 1892-'93, during which time a brush and stone dam (750 linear feet) was constructed at Eau Galle Flats and Plum Island Flats Dam No. 3 was raised at the shore end with one course of brush. The three foundation courses of the latter dam were laid during the winter of 1891-'92. There have not, since then, been sufficient funds available for its completion. The effect, however, of the dam, even in its unfinished condition, has been to materially improve the channel at that point and prevent the water from spreading over a wide area, as it threatened to do and which was the main object in laying the foundation in advance of sufficient funds to warrant completion.

The dam at Eau Galle Flats, built on the ice last winter, received a severe test when the ice went out in the spring. The ice jams were the worst ever known on the river. Most of the works of improvement were injured by more or less stone being pushed off from the top. The injuries were, however, slight except at Eau Galle Flats, where quite a depression, 100 feet in length, occurred in the middle of the new dam. The repair of the latter is now in progress and will cost $300.

In this connection I desire to state that the appropriations for this improvement since 1886 have been inadequate to maintain existing dams in good condition, and at the same time relieve navigation interests by the construction of new works on bars that are serious obstructions to the passage of rafts. The new work is of too recent a date to indicate its permanent effect on the low-water channel.

The following statement shows the cost of work during the past year:

*General expenses.*

| | | |
|---|---|---|
| Care of property, superintendence, and St. Paul office expenses | | $1,747.90 |
| Plum Island Flats Dam No. 2, general repairs | | 100.00 |
| Plum Island Flats Dam No. 3: | | |
| Placing 3½ cords stone, at $1.25; 10 cords brush, at 50 cents. | $9.37 | |
| General repairs | 99.79 | |
| | | 109.16 |

| | | |
|---|---|---|
| Materials on hand at Plum Island, 53⅛ cords stone, at $5 | | $265.62 |
| Eau Galle Flats Dam No. 1: | | |
| 506.688 cords brush | $772.81 | |
| 193.170 cords stone | 1,077.73 | |
| Placing above stone and brush | 992.89 | |
| | | 2,843.43 |
| Materials on hand at Eau Galle Flats: | | |
| 33½ cords stone, at $5.25 | 175.87 | |
| 62 cords brush, at $1.75 | 108.50 | |
| | | 284.37 |
| Materials on hand at Durand, 15 cords stone, at $6.50 | | 97.50 |
| Total expenses for the year | | 5,447.98 |

*Distribution of materials on hand June 30, 1892.*

| | |
|---|---|
| Plum Island Flats Dam No. 3, 3½ cords brush, at $1.72$\frac{7}{17}$ | $6.04 |
| Remaining on hand June 30, 1893, 81½ cords brush, at $1.72$\frac{7}{17}$ | 140.51 |

*Statement of materials on hand June 30, 1893.*

| | |
|---|---|
| Plum Island: | |
| 81½ cords brush, at $1.72 | $140.51 |
| 53⅛ cords stone, at $5 | 265.62 |
| Eau Galle Flats: | |
| 62 cords brush, at $1.75 | 108.50 |
| 33½ cords stone, at $5.25 | 175.87 |
| Durand, Wis., 15 cords stone, at $6.50 | 97.50 |
| Total value | 788.00 |

Mr. A. O. Powell, assistant engineer on this improvement, has exhibited faithfulness and zeal in carrying out the work intrusted to him.

Expenses during the fiscal year ending June 30, 1893, including outstanding liabilities, $5,447.98.

The sum of $60,000 can be profitably expended during the fiscal year ending June 30, 1895.

This work is in the collection district of Milwaukee, Wis. The duties on imports collected during the year ending December 31, 1892, amounted to $465,833.

*Abstract of appropriations.*

| By act— | | By act— | |
|---|---|---|---|
| Approved August 14, 1876 | $10,000 | Approved August 5, 1886 | $18,750 |
| Approved June 8, 1878 | 10,000 | Of August 11, 1886 | 10,000 |
| Approved March 3, 1879 | 8,000 | Approved September 19, 1890 | 10,000 |
| Approved June 14, 1880 | 10,000 | Approved July 13, 1892 | 5,000 |
| Approved March 3, 1881 | 10,000 | | |
| Passed August 2, 1882 | 65,000 | Total | 171,750 |
| Approved July 5, 1884 | 15,000 | | |

*Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $1,713.98 |
| Amount appropriated by act approved July 13, 1892 | 5,000.00 |
| | 6,713.98 |
| June 30, 1893, amount expended during fiscal year | 5,588.42 |
| July 1, 1893, balance unexpended | 1,125.56 |
| July 1, 1893, outstanding liabilities | 398.32 |
| July 1, 1893, balance available | 727.24 |
| Amount (estimated) required for completion of existing project | 100,737.72 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895 | 60,000.00 |
| Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893. | |

### COMMERCIAL STATISTICS.

*Comparative statement of lumber, laths, shingles, pickets, and logs for eleven years.*

| Year. | Lumber. | Laths. | Shingles. | Pickets. | Total tonnage exclusive of loose logs. | Beef Slough logs. |
|---|---|---|---|---|---|---|
| | *Feet, B. M.* | *Number.* | *Number.* | *Number.* | *Tons.* | *Feet, B. M.* |
| 1892 | 144, 651, 150 | 46, 541, 170 | 109, 856, 000 | 1, 507, 050 | 410, 960 | 632, 350, 670 |
| 1891 | 152, 040, 386 | 107. 841, 850 | 48, 700, 210 | 1, 258, 850 | 314, 085 | 284, 118, 430 |
| 1890 | 166, 477, 966 | 46, 234. 673 | 78, 499, 500 | 1, 222, 989 | 342, 350 | 606, 992, 790 |
| 1889 | 158, 938, 294 | 50, 487, 355 | 112, 053, 075 | 2, 244, 786 | 329, 156 | 400, 518, 720 |
| 1888 | 161, 309, 512 | 50, 544, 370 | 86, 348, 900 | 1, 500, 320 | 325, 971 | 542, 437, 000 |
| 1887 | 186, 826, 521 | 64, 725, 580 | 130, 516, 200 | 3, 023, 235 | ............ | 404, 302, 650 |
| 1886 | 207, 205, 672 | 77, 729, 630 | 158, 645, 750 | 1, 934, 340 | ............ | 465, 000, 000 |
| 1885 | 374, 138, 443 | 95, 992, 900 | 195, 880, 220 | 75, 000, 000 | ............ | 600, 000, 000 |
| 1884 | 298, 344, 591 | 88, 905, 520 | 160, 133, 000 | 1, 840, 273 | ............ | 534, 674, 176 |
| 1883 | 269, 094, 203 | 82, 643, 500 | 129, 754, 000 | 1, 497, 948 | ............ | 450, 000, 000 |
| 1882 | 375, 000, 000 | 66, 000, 000 | 150, 000, 000 | 2, 200, 000 | ............ | 350, 000, 000 |

*Comparative statement of freight and passengers for twelve years.*

| Year. | Steamboats. | Freight carried. | Passengers. | Year. | Steamboats. | Freight carried. | Passengers. |
|---|---|---|---|---|---|---|---|
| | | *Pounds.* | | | | *Pounds.* | |
| 1892 | *1 | .......... | .......... | 1886 | 1 | .......... | 4, 700 |
| 1891 | *1 | .......... | .......... | 1885 | 1 | 690, 000 | 4, 728 |
| 1890 | *1 | .......... | .......... | 1884 | 2 | 1, 500, 000 | 5, 500 |
| 1889 | *1 | .......... | .......... | 1883 | 3 | 3, 184, 000 | 4, 000 |
| 1888 | *1 | .......... | .......... | 1882 | 3 | 2, 640, 000 | 10, 490 |
| 1887 | 1 | 600, 000 | 1, 400 | 1881 | 3 | 3, 932, 000 | 16, 989 |

* One hundred and eight tons burden and 2 feet draft.

But one steamboat plied regularly on the river during the past four seasons. This boat, the *Phil Sheckel* (108 tons burden and 2 feet draft), ran from the mouth to Dunnville, about half-way between the mouth and Eau Claire to assist the Knapp, Stout and Co. Company's rafts in floating down the river. Her passengers and freight were confined entirely to the company's rafting business.

## A A 4.

## IMPROVEMENT OF ST. CROIX RIVER, WISCONSIN AND MINNESOTA.

The original project for the improvement of this river, adopted in 1878, was based upon the results of a survey made in 1874, when the St. Croix was at a high stage of water, and but comparatively few bars, etc., to be seen, and contemplated the removal of snags, bowlders, wrecks, leaning trees, and sand bars between Taylor Falls and Prescott, and contraction of low-water channel between Taylor Falls and Stillwater into one of nearly uniform width, by means of brush and stone jetties, and dams of the same material, to close island chutes and secondary channels. Estimated cost, $21,758.

The lower part of the river is known as Lake St. Croix. Stillwater, at the head of the lake, divides the navigable portion of the river into two sections: The upper or river section, 28½ miles in length, and the lower or lake section, 23.8 miles in length. The present project, adopted in 1880 and modified in 1882, and again in 1889 (see p. 1801, Annual Report, 1889), by my predecessor, is based upon results of a low-water survey made in 1879. The estimated cost has been placed at $108,700.

In the Annual Report for 1889 he reported:

> The first appropriation for the improvement of the St. Croix was $10,000 made by act of Congress approved June 18, 1878.
>
> At that date the channel, above Stillwater especially, was encumbered by sunken cribs, wrecks, snags, and old boom piers, and the bends by leaning trees. The low-water channel had in many places but 2 feet of depth, and steamers and barges made their way as best they could amongst the obstructions. At times it was impossible for them to get over the shoal places. Under this appropriation some of the worst obstructions were removed between Taylor Falls and Stillwater.

The free navigation of the lower section was obstructed by partly sunken logs and by the Hudson and Catfish bars, 6.3 and 15.1 miles, respectively, below Stillwater. The channel over the Hudson Bar was quite tortuous and shallow, having but 2½ feet depth at low water. At Catfish the channel had sufficient depth, but made a sharp bend around a long, narrow sand spit that jutted out for a distance of 1,450 feet from the left bank and at right angles to the shore line. When a strong wind blew up or down the lake the steamboats with heavy rafts encountered considerable difficulty in keeping the channel.

The improvements to June 30, 1891, resulted in a decidedly improved channel above Stillwater to the advantage of the river traffic then existing. The improvement consisted in the removal of sunken cribs, wrecks, snags, old boom piers, and leaning trees, and the construction of wing dams to contract the channel over the worst bars, and thereby increased the depth over the bars worked on from an original low-water depth of 2 to 3 feet.

Since 1886 the railroads penetrating the region have reduced navigation over this section to almost nothing, except the running of loose logs; as a consequence, little attention during the past six years has been given to the improvement of this section.

On the lower section (Stillwater to the mouth) the commerce, consisting of rafted lumber and logs towed by steamboats, is of large proportions and its needs are being met by expending the largest part of appropriations on this reach. By June 30, 1892, channels had been dredged through the Catfish and Hudson bars to a depth of 4 feet at low water, and the water directed into new channels by training dams.

Many of the partly submerged logs were also removed, but new ones are continually coming into the channel. The work has resulted in creating a fair steamboat channel, 4 feet deep at low water, from Stillwater to the mouth. Boats and rafts can now pass over that distance at the lowest stages; but some work remains to be done in widening the dredged channels and straightening other portions, particularly on the Hudson Bar above and below the bridge.

Expended under the present project to June 30, 1892, including outstanding liabilities, $82,461.02.

Total expended under original and present projects to June 30, 1892, including outstanding liabilities, $100,461.02.

Operations during the past fiscal year: Work was confined to dredging a channel through a small bar at head of Lake St. Croix and in widening the channel over the Hudson Bar. Total amount of excavation, 15,724.32 cubic yards. The work at Hudson Bar has facilitated the passage of raft boats with their large tows.

Total expended during the fiscal year ending June 30, 1893, including outstanding liabilities, $5,551.19.

This work is in the collection district of Minnesota, of which St. Paul is the port of entry and St. Vincent a subport. Collections for the year ending December 31, 1892, $124,177.40; value of domestic exports for same period, $282,736.

*Abstract of appropriations.*

| By act— | |
|---|---|
| Approved June 18, 1878 | *$10,000 |
| Approved March 3, 1879 | *8,000 |
| Approved June 14, 1880 | 10,000 |
| Approved March 3, 1881 | 8,000 |
| Passed August 2, 1882 | 30,000 |
| Approved July 5, 1884 | 9,000 |
| Approved August 5, 1886 | $7,500 |
| Of August 11, 1888 | 10,000 |
| Approved September 19, 1890 | 8,000 |
| Approved July 13, 1892 | 8,000 |
| Total | 108,000 |

## *Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $49.44 |
| Amount appropriated by act approved July 13, 1892 | 8,000.00 |
| | 8,049.44 |
| June 30, 1893, amount expended during fiscal year | 5,220.49 |
| July 1, 1893, balance unexpended | 2,828.95 |
| July 1, 1893, outstanding liabilities | 341.16 |
| July 1, 1893, balance available | 2,487.79 |
| Amount (estimated) required for completion of existing project | 18,200.00 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895 | 18,200.00 |

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

### COMMERCIAL STATISTICS.

*Comparative statement of steamboats and barges, freight and passengers carried, lumber and logs towed and rafted on the St. Croix River, Wisconsin and Minnesota, for a period of fifteen years.*

STEAMBOATS AND BARGES.

| Year. | In freight and passenger business. | | Steamboats in towing and rafting business. | Year. | In freight and passenger business. | | Steamboats in towing and rafting business. |
|---|---|---|---|---|---|---|---|
| | Steamboats. | Barges. | | | Steamboats. | Barges. | |
| 1878[1] | 8 | ........ | 8 | 1886 | 6 | 38 | 49 |
| 1879 | 3 | ........ | 12 | 1887 | 3 | 40 | 58 |
| 1880 | 3 | ........ | 29 | 1888 | 1 | 3 | 58 |
| 1881 | 2 | ........ | 40 | 1889 | 1 | 3 | 52 |
| 1882 | 8 | 24 | 77 | 1890 | 2 | 3 | 126 |
| 1883 | 3 | 25 | 51 | 1891 | [2]1 | 0 | [3]130 |
| 1884 | 3 | 25 | 30 | 1892[4] | 0 | 0 | [3]122 |
| 1885 | 4 | 33 | 50 | | | | |

[1] Amount of commerce and navigation when work of improvement began.
[2] 117 tons burden and 18 inches draft.
[3] From 35 to 240 tons burden and 2½ to 3½ feet draft.
[4] Amount of commerce and navigation at present time.

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*Appropriated before adoption of present project.

*Comparative statement of steamboats and barges, freight and passengers carried, lumber and logs towed and rafted on the St. Croix River, etc.*—Continued.

### FREIGHT AND PASSENGERS.

| Year. | Freight carried. | | | | | Passengers carried. |
|---|---|---|---|---|---|---|
| | General merchandise. | Lumber. | Wood. | Total to 1887, inclusive. | Total. | |
| | *Tons.* | *Tons.* | *Tons.* | *Pounds.* | *Tons.* | |
| 1878* | | | | 32,000,000 | | 15,009 |
| 1879 | | | | 47,786,995 | | 9,244 |
| 1880 | | | | (†) | | (†) |
| 1881 | | | | 35,000,000 | | 11,615 |
| 1882 | | | | 60,000,000 | | 10,309 |
| 1883 | | | | 63,000,000 | | 12,809 |
| 1884 | | | | 80,000,000 | | 4,009 |
| 1885 | | | | 85,000,000 | | 10,647 |
| 1886 | | | | 180,900,000 | | 12,756 |
| 1887 | | | | 57,009,320 | | 9,872 |
| 1888 | | 5,200 | 4,354 | | 9,554 | |
| 1889 | | 5,900 | 4,100 | | 10,000 | |
| 1890 | 209 | 7,139 | 5,796 | | 13,144 | 921 |
| 1891 | | 100 | 200 | | 300 | 551 |
| 1892 | | | | | | |

* Amount of commerce and navigation when work of improvement began.
† Unknown.

### RAFTED LOGS AND LUMBER.

| Year. | Rafted logs towed out of St. Croix River (estimated). | Rafted lumber towed out of St. Croix River. | | | | Total tonnage. |
|---|---|---|---|---|---|---|
| | | Lumber. | Shingles. | Laths. | Pickets. | |
| | *Feet, B. M.* | *Feet, B. M.* | *Number.* | *Number.* | *Number.* | *Tons.* |
| 1878 | 70,000,000 | | | | | |
| 1879 | 117,000,000 | | | | | |
| 1880 | 200,000,000 | | | | | |
| 1881 | 185,000,000 | | | | | |
| 1882 | 130,000,000 | | | | | |
| 1883 | 108,000,000 | | | | | |
| 1884 | 175,000,000 | | | | | |
| 1885 | 150,000,000 | | | | | |
| 1886 | 115,000,000 | | | | | |
| 1887 | 175,000,000 | 100,000,000 | | | | |
| 1888 | 136,000,000 | 114,610,966 | 40,079,500 | 23,651,800 | 570,820 | 706,367 |
| 1889 | 150,000,000 | 81,817,070 | 38,633,000 | 23,226,575 | 90,800 | 697,344 |
| 1890 | 250,000,000 | 116,403,000 | 46,007,000 | 33,861,900 | 278,580 | 1,164,109 |
| 1891 | 209,233,490 | 110,934,084 | 32,016,750 | 31,132,350 | 678,240 | 948,757 |
| 1892 | 250,000,000 | 126,503,620 | 51,959,000 | 37,387,200 | 261,040 | 1,179,549 |

Loose logs driven on St. Croix River to head of lake during season of 1892 were 436,899,770 feet, B. M., or 1,529,149 tons.

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## A A 5.

## IMPROVEMENT OF MINNESOTA RIVER, MINNESOTA.

An examination of this stream was made by Maj. G. K. Warren, Corps of Engineers, in 1866, under authorization of section 4 of the act of Congress approved June 23, 1866. Major Warren's first or preliminary report of this survey was rendered January 21, 1867, and printed as a part of Senate Ex. Doc. No. 58, Thirty-ninth Congress, second session.

The estimates of cost of improvement, based upon results of this examination and survey, are given in the report of the Chief of Engineers for the year ending June 30, 1867. Two plans are considered, viz, one to improve the navigation of the river from the Yellow Medicine to the mouth of the Minnesota by means of locks and dams, so as to secure 4 feet of water, at a cost of $775,500, and another to secure 2 to 3 feet of water by removal of snags and bowlders throughout this stretch of the river, in addition to the construction of a lock and dam at Little Falls and the operation of a scraper and dredge boat, at a cost of $117,000.

The river and harbor act of Congress approved March 2, 1867, appropriated $37,500 for removing snags and bowlders throughout the Minnesota River, thus sanctioning the second plan.

The river and harbor acts of Congress approved June 11, 1870, and March 3, 1871, each appropriated $10,000 for continuing the improvement.

The second section of the river and harbor act of Congress approved June 10, 1872, provided for the survey of the Minnesota River above the mouth of the Yellow Medicine, which survey was made during the same year, the report pertaining to which is printed in the report of the Chief of Engineers for the fiscal year ending June 30, 1873. The removal of obstructions, principally bowlders, was recommended.

The same act (approved June 10, 1872) appropriated $10,000 for the improvement of the stream, which sum was expended in the removal of bowlders, overhanging trees, etc.

By act approved March 3, 1873, there was appropriated—

> For the improvement of Minnesota River, Minnesota, $10,000; provided, that one-half of said sum shall be expended between the mouth of the Yellow Medicine and Minnesota Falls on said river.

This appropriation was applied to the removal of rocky ledges, bowlders, snags, and overhanging trees. The total of appropriations to March 3, 1873, inclusive, was $77,500.

By act of Congress approved June 23, 1874, an appropriation of $10,000 was made "for the survey or improvement of Minnesota River." A survey was made from the mouth of the river to South Bend, a distance of 116.4 miles, to determine the practicability of improving navigation by means of canals, locks and dams. The results of this survey proved the possibility of a lock-and-dam navigation for the distance passed over, the estimated cost of improvement, as stated in the report of the survey printed in the Annual Report of the Chief of Engineers for the fiscal year ending June 30, 1875, being for five locks and dams, removal of snags, etc., $733,868.63, the cost of removing snags, etc., being therein placed at $34,585.10, including contingencies. Following this report, Congress made three appropriations of $10,000 each by acts approved March 3, 1875, August 14, 1876, and June 18, 1878, which sums were applied to clearing the river of obstructions below South Bend.

The appropriations up to and including that of June 18, 1878, were applied in removing snags, bowlders, etc., on the upper part of the river, between Minnesota Falls and a point 30 miles below Henderson (16.7 miles above Shakopee). The rapidly caving banks on this stretch of the river add snags and leaning trees to the channel yearly, so that channels that were cleared twelve years ago are encumbered with them to-day.

No money has been spent on the lower part of the river, which presents a marked contrast to the upper section.

Below Shakopee the river is, in the main, very deep, almost free from snags and caving banks, and would offer exceptional advantages to the navigation thereof were communication between it and the Mississippi River rendered possible by the improvement of the bar at the mouth of the river and an increased depth provided over Credit River Bar (or Petersons Bar, as it is sometimes called), just below Shakopee.

It is claimed by those interested in the Minnesota Valley that, were the improvements extended by the construction of locks and dams, steamboats and barges would navigate the river and carry much of the freight that now depends upon rail for transportation.

The river and harbor act of Congress approved August 5, 1886, authorized a survey of the Minnesota River, with a view to its improvement by locks and dams. The survey, extending from the mouth of the river to Mankato, was made by my predecessor during the season of 1887, and a report thereon, with maps, rendered January 16, 1888. This report was printed in House Ex. Doc. No. 158, Fiftieth Congress, first session.

By the river and harbor act of August 11, 1888, Congress appropriated for—

> Improving Minnesota River, Minnesota, including protecting and holding the banks opposite the borough of Belle Plaine, so as to prevent the river from cutting through the narrow neck of land at that point and thereby changing its channel and course, $10,000.

This is the first appropriation made since 1878 for the improvement of the Minnesota River. Concerning the expenditure of this appropriation, my predecessor reported (see p. 1804, Annual Report, 1889):

> An examination of the river at Belle Plaine, and also from Carver to the mouth of the stream, was made in September, 1888, with a view to obtaining data upon which to base a project for the advantageous expenditure of the sum appropriated by the act of August 11, 1888.
>
> The examination showed that there had not been any marked erosion of the bend at Belle Plaine for several years past, but that to thoroughly protect it against such erosion as might occur from floods or from changes in the channels of the river above the bend would undoubtedly cost more than the entire sum appropriated for the river. It also showed that there had not been any steamboat navigation of the river at that point (an occasional trip by steamboat at high water excepted) for a number of years.
>
> The cost of an adequate open-channel improvement of the river from its mouth to Carver, such an improvement as might last for a number of years, was found to be not less than $52,000.
>
> The appropriation being inadequate for thorough work at either Belle Plaine or the extent of river from its mouth to Carver, and still less adequate for the performance of work if divided between them, it was recommended that the submitting of a project for expenditure of the appropriation be delayed until the further wishes of Congress might be known, or until some definite information as to prospective navigation might be obtained, upon which to base a project for the best utilization of the appropriation.

Since the submission of the foregoing report it has been represented by reliable parties that a large amount of brick, hay, lime, and wood would be carried by steamboats and barges from points near Shakopee to St. Paul were navigation made certain throughout the season, and there is an excellent opportunity for a general packet business between the Mississippi River and points on the lower Minnesota River, which would result in a material reduction of freight rates between these points.

In this connection I quote from my predecessor, Major Allen (see Annual Report Chief of Engineers, 1888, p. 1574):

> From consideration of all the facts that I have been able to collect, I am of the opinion that the Minnesota River, from its mouth to Mankato, is worthy of improvement.

The river and harbor act approved July 13, 1892, made the sum appropriated by act of August 11, 1888, "available for the improvement of the river, omitting the requirement for operations at Belle Plaine."

Total expended under the project following the survey of 1874 to June 30, 1892, including outstanding liabilities, $30,042.

Total expended under all projects, including the survey, to June 30, 1892, inclusive, $117,542.79.

The only work performed during the past year has been a survey and examination of the mouth of the river upon which to base plans for its improvement. Active work of improvement will be carried on during the ensuing year.

Amount expended during the fiscal ending June 30, 1893, $102.20.

The sum of $35,000 can be profitably expended during the fiscal year ending June 30, 1895.

This work is in the collection district of Minnesota, of which St. Paul is the port of entry and St. Vincent a subport. Collections for the year ending December 31, 1892, $424,177.40; value of domestic exports for same period, $282,736.

*Abstract of appropriations.*

| | | | |
|---|---|---|---|
| By act approved— | | By act approved— | |
| March 3, 1867 | $37,500 | March 3, 1875 | $10,000 |
| July 11, 1870 | 10,000 | August 14, 1876 | 10,000 |
| March 3, 1871 | 10,000 | June 18, 1878 | 10,000 |
| June 10, 1872 | 10,000 | By act of August 11, 1888 | 10,000 |
| March 3, 1873 | 10,000 | | |
| June 23, 1874 | 10,000 | Total | 127,500 |

*Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $9,967.00 |
| June 30, 1893, amount expended during fiscal year | 93.45 |
| July 1, 1893, balance unexpended | 9,873.55 |
| July 1, 1893, outstanding liabilities | 18.54 |
| July 1, 1893, balance available | 9,855.01 |
| Amount (estimated) required for completion of existing project | 693,868.63 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895 | 35,000.00 |

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

COMMERCIAL STATISTICS.

| Year. | Steamboats plying on lower part of river. | | | Freight carried. | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | No. | Tonnage. | Draft. | Wheat. | Hay. | Wood. | Brick. | Miscellaneous. | Total. |
| | | *Tons.* | *Inches.* | *Tons.* | *Tons.* | *Tons.* | *Tons.* | *Tons.* | *Tons.* |
| 1888 | 1 | | | | | | | | 3,350 |
| 1889 | 2 | 153<br>180 | 18<br>20 | | | | | | 4,900 |
| 1890 | 3 | 117<br>153<br>180 | 18<br>30<br>20 | 62 | 809 | 840 | 1,080 | 842¼ | 3,633¼ |
| 1891 | | | | | | | | | |
| 1892 | | | | | | | | | |

There was no traffic on the river during the seasons of 1891-'92, as steamboats could not pass the bar at the mouth of the river.

## A A 6.

### IMPROVEMENT OF RED RIVER OF THE NORTH, MINNESOTA AND NORTH DAKOTA.

The present, which is also the original, project for the improvement of this river from Breckinridge to the northern boundary line, adopted in 1877 and amended as to estimate of cost in 1883, consists in the removal of snags, leaning trees, and bowlders and in dredging channels through the bars.

The estimated cost of this improvement, omitting the item of improvement of Goose Rapids, as based upon the reports of 1874, 1875, and 1877 (see pp. 730–732, Report of Chief of Engineers, 1878), was $145,310.18, which estimate as revised, and for the reasons stated in Appendix X 8 of the Annual Report of 1883, was increased to $179,310.18.

The river and harbor act of Congress approved August 5, 1886, making the money theretofore appropriated for locks and dams at Goose Rapids available for dredging, removal of snags and bowlders, and construction of wing dams necessarily included in that mode of improving Goose Rapids, which were originally intended to be improved by means of locks. For this reason, as well as for others given in the Annual Report of 1887, a new estimate of cost of completing the work became necessary. The cost was placed at $79,598.37. (See Appendix A A to the Annual Report of the Chief of Engineers for 1887, pp. 1714, 1715).

A new estimate for the completion of the project is now given:

| | |
|---|---|
| Channel obstructions: Goose Rapids to Breckinridge, snags, bowlders, trees, etc | $14,400 |
| Dredging: Grand Forks to Fort Abercrombie, 180,000 cubic yards excavation, at 26 cents per cubic yard | 46,800 |
| | 61,200 |
| For contingencies, 10 per cent | 6,120 |
| Total | 67,320 |

The increased cost has arisen from two sources:

(1) The eight-hour law.

(2) A large increase in the quantity of material excavated north of Grand Forks, where the project was completed last season. As the main bars were removed intermediate shallow bars appeared which had not been noticed in the survey, upon which the original estimate was made.

For the effect of the eight-hour law, in relation to the cost of the work, attention is invited to the report appended hereto of Mr. R. Davenport, assistant engineer.

Previous to 1879, when the first bar was dredged through, the ruling depth at ordinary low water between Moorhead and Goose Rapids has been stated to have been but 1½ feet, and below Grand Forks but 2 feet. The dredging work to June 30, 1891, has resulted in a 3-foot channel at ordinary low water, averaging 50 feet in width, from Moorhead to a point 80 miles north, and a 4-foot channel at same stage, averaging 70 feet in width, from Grand Forks to a point 62 miles north, by river, have been made by dredging through the bars.

The river is subject to land slides. These slides can never be anticipated, form obstructions when they occur, and have to be removed in whole or in part, thereby increasing the amount of cost of the improvement. The removal of snags and trees between Moorhead and Abercrombie improved that section of the stream for navigation during high and medium stages of water.

Expended upon the improvement from commencement of work in 1877 to June 30, 1892, including outstanding liabilities, $214,180.60.

### OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1893.

The fieldwork consisted in repairs to the fleet, operating two dredges north of Grand Forks between August 10 and October 27, 1892, and one dredge on Goose Rapid Flats between May 17 and June 30, 1893.

The result of the year's work has been to complete the improvement north of Grand Forks by dredging a channel through the bars 60 feet wide and 4 feet deep, and in improving 1 mile of river over Goose Rapids Flat.

The quantities of dredging in detail have been as follows:

| | | |
|---|---|---|
| Excavation | cubic yards.. | 65,542 |
| Training dams | linear feet.. | 22,850 |
| Wing dams | do.... | 495 |
| Channels cut | do.... | 22,850 |

For a more detailed account of the year's operations attention is invited to the report of Assistant Engineer R. Davenport, herewith.

The total work done on this stream since the first appropriation for its improvement was made in 1876, and extending from Fort Abercrombie north to the boundary line, a total river distance of 309.5 miles, is as follows:

| | | |
|---|---|---|
| Material dredged | cubic yards.. | 749,162 |
| Snags removed | | 635 |
| Bowlders removed | cubic yards.. | 409½ |
| Overhanging trees removed | | 8,722 |
| Stumps removed | | 198 |
| Piles removed | | 23 |
| Drift piles (collection of driftwood, trees, etc.) | | 8 |
| Barge removed | | 1 |
| Channel excavated | linear feet.. | 149,659 |
| Wing and training dams constructed | do.... | 193,180 |

On the portions of the river worked over by the dredges the average depth of the channel has been increased from 1½ feet to 2 feet.

Mr. Rufus Davenport, assistant engineer upon this improvement for the past eleven seasons, has exhibited faithfulness and zeal in carrying out the work intrusted to him.

All of the work for the improvement of this stream has been performed by hired labor.

Expended upon this improvement during the fiscal year ending June 30, 1893, including outstanding liabilities, $20,595.34.

This work is in the collection district of Minnesota and North and South Dakota. Collections for the year ending December 31, 1892, $18,069.17. Value of domestic exports for same period, $556,928.

*Abstract of appropriations.*

| By act— | | By act— | |
|---|---|---|---|
| Approved August 14, 1876 | $10,000.00 | Approved August 5, 1886. | $46,947.65 |
| Approved June 18, 1878.. | 30,000.00 | Of August 11, 1888....... | 20,000.00 |
| Approved March 3, 1879. | 25,000.00 | Approved September 19, 1890 .................. | 25,000.00 |
| Approved June 14, 1880.. | 20,000.00 | Approved July 13, 1892.. | 25,000.00 |
| Approved March 3, 1881. | 18,000.00 | | |
| Passed August 2, 1882... | 10,000.00 | | |
| Approved July 5, 1884... | 10,000.00 | Total ................. | 239,947.65 |

### *Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $2,067.05 |
| Amount appropriated by act approved July 13, 1892 | 25,000.00 |
| | 27,067.05 |
| June 30, 1893, amount expended during fiscal year | 19,106.55 |
| July 1, 1893, balance unexpended | 7,960.50 |
| July 1, 1893, outstanding liabilities | 2,788.79 |
| July 1, 1893, balance available | 5,171.71 |
| Amount (estimated) required for completion of existing project | 67,320.00 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895 | 67,320.00 |

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

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#### REPORT OF MR. R. DAVENPORT, ASSISTANT ENGINEER.

GRAND FORKS, N. DAK., *April 30, 1893.*

MAJOR: The following estimate, as the increased cost under the new eight-hour law, of continuing the improvement of the Red River of the North to completion as per existing project is respectfully submitted.

In the estimate submitted January 1, 1892, the cost of the proposed improvement now remaining to be done was as follows:

| | |
|---|---|
| Channel obstructions: Removal of snags, bowlders, and overhanging trees, Goose Rapids to Breckinridge | $12,000 |
| Dredging: Grand Forks to Fort Abercrombie, 180,000 cubic yards excavation, at 30 cents per yard | 36,000 |
| | 48,000 |
| For contingent expenses, 10 per cent | 4,800 |
| Total | 52,800 |

Based upon experience of last season's work, it is now estimated that the actual cost of the work under the new law will be increased 20 per cent—$10,560. And as the work now remaining to be done will, under the new law, require one more season's work than was originally estimated, it will be necessary to add the cost of repairing and maintaining the dredging fleet for another year, at an estimated cost of $4,000. An increase of $15,560, which, with 10 per cent for contingencies on the increase, makes the total increased cost, attributable to the new eight-hour law, $16,016.

*Summary of estimate of January 1, 1892.*

| | |
|---|---|
| Channel obstructions: Goose Rapids to Breckinridge, snags, bowlders, etc. | $12,000 |
| Dredging: Grand Forks to Fort Abercrombie,* 230,000 cubic yards excavation, at 20 cents per cubic yard | 46,000 |
| | 58,000 |
| For contingencies, 10 per cent | 5,800 |
| Total | 63,800 |

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* The dredging between Grand Forks and Pembina, 50,000 cubic yards excavation, was completed during the season of 1892.

*Summary of estimates of April 14, 1893.*

| | |
|---|---|
| Channel obstructions: Goose Rapids to Breckenridge, snags, bowlders, trees, etc | $14,400 |
| Dredging: Grand Forks to Fort Abercrombie,* 180,000 cubic yards excavation, at 26 cents per cubic yard | 46,800 |
| | 61,200 |
| For contingencies, 10 per cent | 6,120 |
| Total | 67,320 |

The increase in the estimate on account of the increase in dredging was contained in the estimate of January 1, 1892, $20,201.63. (Annual Report of the Chief of Engineers for 1892, pp. 1845, 1846, 1847.)

Very respectfully, your obedient servant,

R. DAVENPORT,
*Assistant Engineer.*

Maj. W. A. JONES,
*Corps of Engineers, U. S. A.*

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REPORT OF MR. R. DAVENPORT, ASSISTANT ENGINEER.

GRAND FORKS, N. DAK., *June 30, 1893.*

MAJOR: The following report of operations in the improvement of the Red River of the North during the fiscal year ending June 30, 1893, is respectfully submitted:

During the last half of the season of 1892 the work of improvement on the river was confined to channel dredging north of Grand Forks.

The order to commence operations was received August 1 and the work of preparation was at once started. Dredge *Otter Tail* began work on the channel 17 miles north of Grand Forks August 10, and dredge *Unser Fritz* commenced on the bars 6 miles south of Drayton on the 15th of August.

The channel improvement was carried on by both dredges during the months of August, September, and October until all the work required on the section of river between Grand Forks and Pembina was completed, when both boats were towed up the river to Grand Forks, dredge *Otter Tail* arriving on the 26th and dredge *Unser Fritz* on the 27th of October.

After the return of the boats to Grand Forks both dredges were hauled out on the ways and their hulls calked and repaired. Three of the old barges were also removed from the water and thoroughly repaired, calked, and painted; a new forecastle deck was put on the steamer *Ogama*, and the boiler casing rebuilt.

The cost of the repairs made after the close of the season's work was $2,874.55, divided as follows: Dredge *Unser Fritz*, $398.72; dredge *Otter Tail*, $401.24; steamer *Ogama*, $548.92; barge No. 1, $572.27; barge No. 2, $572.28; barge No. 3, $381.12. The repair work at Grand Forks was brought to a close November 16.

The repair work on the fleet was made as complete as possible, so as to put the entire outfit in shape for the early resumption of work in the spring, with the exception only of the covering which it was proposed to place on the boilers of the steamboat and dredge, which latter work, owing to the length of time which had been occupied on the general repairs, it was concluded could be done to the best advantage just before operations were commenced the following year.

*Dredging.*—Dredge *Unser Fritz* commenced work on the bars 6 miles south of Drayton, N. Dak., August 15, working from that point north over some 12 miles of river, widening the 35-foot channels of the previous season and cutting channels of the standard width, 60 feet, through the remaining bars.

Total excavation, 23,989 cubic yards; length of channel cuttings 10,290 linear feet; number of cuttings made, 7. With the excavated material 10,290 linear feet of training dams and 215 linear feet of wing dams were constructed.

Dredge *Otter Tail* commenced work on the channel 17 miles north of Grand Forks August 10, working from that point toward Drayton; widening and extending a a few of the old cuttings, and excavating channels of the standard width through the few remaining bars that had been previously passed over. Length of river worked over, 66 miles.

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* The dredging between Grand Forks and Pembina, 50,000 cubic yards excavation, was completed during the season of 1892.

Total excavation, 26,987 cubic yards; length of channel cuttings, 8,410 linear feet; number of cuttings made, 11. With the excavated material, 8,410 linear feet of training dams and 419 linear feet of wing dams were formed.

The steamer *Ogama* was operated in connection with the dredges; towing the dredges and wood barges, and keeping the fleet supplied with fuel, subsistence, etc. Number of trips made, 48; total miles run, 1,815; wood loaded, 372½ cords. The cost of operating the steamboat is included in the cost of the dredging.

*Dredging in detail, season of 1892.*

DREDGE UNSER FRITZ.

| No. of cut. | Location. | Excavation. | Training dams. | Wing dams. | Channel cut. |
|---|---|---|---|---|---|
| | | *Cub. yds.* | *Lin. ft.* | *Lin. ft.* | *Lin. ft.* |
| 1 | Sec. 6, T. 158, R. 50 W | 5,391 | 1,320 | 215 | 1,320 |
| 2 | Sec. 5, T. 158, R. 50 W | 3,842 | 2,790 | ........ | 2,790 |
| 3 | Sec. 32, T. 159, R. 50 W | 8,312 | 3,830 | ........ | 3,830 |
| 4 | Sec. 18, T. 159, R. 50 W | 1,285 | 400 | ........ | 400 |
| 5 | Sec. 8, T. 159, R. 50 W | 2,600 | 1,200 | ........ | 1,200 |
| 6 | Sec. 8, T. 159, R. 50 W | 1,485 | 400 | ........ | 400 |
| 7 | Sec. 6, T. 159, R. 50 W | 1,074 | 350 | ........ | 350 |
| | Total | 23,989 | 10.290 | 215 | 10,290 |

DREDGE OTTER TAIL.

| | | | | | |
|---|---|---|---|---|---|
| 1 | Sec. 5, T. 153, R. 50 W | 1,475 | 600 | ........ | 600 |
| 2 | Sec. 6, T. 154, R. 50 W | 1,148 | 225 | 60 | 225 |
| 3 | Sec. 8, T. 155, R. 50 W | 400 | 200 | ........ | 200 |
| 4 | Sec. 6, T. 155, R. 50 W | 1,467 | 700 | ........ | 700 |
| 5 | Sec. 30, T. 157, R. 50 W | 937 | 250 | ........ | 250 |
| 6 | Sec. 5, T. 157, R. 50 W | 2,146 | 1,380 | ........ | 1,380 |
| 7 | Sec. 32, T, 158, R. 50 W | 1,018 | 200 | ........ | 200 |
| 8 | Sec. 8, T. 158, R. 50 W | 11,888 | 3,380 | 50 | 3,380 |
| 9 | Sec. 8, T. 158, R. 50 W | 437 | 150 | ........ | 150 |
| 10 | Sec. 7, T. 158. R. 50 W | 4,871 | 1,000 | 170 | 1,000 |
| 11 | Sec. 29, T. 155, R. 50 W | 1,200 | 325 | ........ | 325 |
| | Total | 26,978 | 8,410 | 280 | 8,410 |

The cost of the dredging in 1892, as compared with that of 1891, shows an increase of about 45 per cent. This increase was partly owing to the short working season of 1892, about three months, as the cost of preparing the fleet for work, and also that of laying up the boats at the close of the season's operations is about the same for a short period as for a full season's work. There was also in 1892 an increase of about $1 per cord in the cost of wood for fuel for the steamboat and dredges. About 20 per cent of the increase can, however, be directly attributed to the new eight-hour law, which, with the same rate of pay, cost of subsistence, etc., reduced the working hours just one-fifth.

The season's work of 1892 completed the extension of the 4-foot low-water channel between Grand Forks and the boundary line, a distance, by water, of about 143 miles. The channels excavated have an average width of about 60 feet through the bars, and a low-water depth of about 4 feet.

Experience during the last twelve years has proved that the excavated channels, except when disturbed by landslides, are practically permanent, so that, unless slides do occur, it can be reasonably expected that that section of the river will be navigable at low water, for boats not exceeding 4 feet draft, for some years to come.

*Season of 1893.*—The work of completing the repairs on the dredging fleet and preparing for the season's dredging operations was commenced April 11.

The repairs consisted mainly in covering the boilers of the dredge *Otter Tail* and the steamer *Ogama* and repairing the latter boat. The cost of covering the boiler of the steamboat was $178.26 and of the dredge, $217.51; the cost of the painting was $182.93; a total of $578.70.

The progress of the work on the fleet generally was somewhat interfered with and the cost materially increased by the extremely high stage of water in the river this spring. The flood commenced about the middle of April and lasted for more than a month. The highest point reached by the water was 40.5 feet on the Grand Forks guage, a stage only 2 feet lower than the flood of 1882.

The preparatory work on the boats was completed on the 10th of May, and the dredging fleet, consisting of the dredge *Otter Tail* and the necessary barges, etc., was taken in tow by the steamer *Ogama* and started up the river the morning of the 11th; arriving at Goose Rapids Flats, where the work was to be commenced, the evening of the 16th.

The dredge commenced the channel excavation May 17, and to this date has excavated 14,575 cubic yards. Number of cuts made, 3; length of channel cuttings, 4,150 linear feet. With the excavated material 4,150 linear feet of training dams have been constructed.

The steamer *Ogama*, operated in connection with the dredge in towing the fleet and keeping up the supply of fuel, subsistance, etc., made 12 trips, including a trip of inspection from Grand Forks to Fargo and return. Total miles run, 882; wood loaded, 141¼ cords; fascine brush cut and conveyed to the dredge, 11¼ cords.

*Dredging in detail, season of 1893.*

DREDGE OTTER TAIL.

| No. of cut. | Location. | Excavation. | Training dams. | Wing dams. | Channel cut. |
|---|---|---|---|---|---|
| | | *Cubic yards.* | *Linear feet.* | *Linear feet.* | *Linear feet.* |
| 1 | Sec. 2, T. 146, R. 49 | 3,450 | 675 | 0 | 675 |
| 2 | Sec. 1, T. 146, R. 49 | 4,100 | 975 | 0 | 975 |
| 3 | Sec. 1, T. 146, R. 49 | 7,025 | 2,500 | 0 | 2,500 |
| | Total | 14,575 | 4,150 | 0 | 4,150 |

The operations of the dredge this season have so far been confined to the section of the river known as Goose Rapids Flats; the improvement has been extended over about a mile of river.

*Summary.*—Total excavation, 65,542 cubic yards; channel cut, 22,850 linear feet; length of river worked over, 79 miles.

With the excavated material 22,850 linear feet of training dams and 495 linear feet of wing dams have been constructed.

Total miles run by steamboat, 2,697; wood loaded, 514 cords.

The average cost of the excavation, including the cost of placing the material in the wing and training dams, was 16.38 cents per cubic yard; cost of subsistence per ration, 38.2 cents.

Very respectfully, your obedient servant,

R. DAVENPORT,
*Assistant Engineer.*

Maj. W. A. JONES,
*Corps of Engineers, U. S. A.*

COMMERCIAL STATISTICS.

The stage of water in the Red River during the boating season of 1892 was the most favorable of any year since 1885, the range of water on the Grand Forks gauge being from +28.4 feet in April to +0.5 at the end of October, the latter indicating a 4-foot depth of water in the channels from Grand Forks to Pembina. There was also at the lowest a 3-foot stage of water on the river from Grand Forks south, except on the improved portion of Goose Rapids.

The Red River Transportation Company was the only steamboat line operating on the Red River during the season of 1892, their one steamboat, the *W. H. Alsop* (157 tons), and a fleet of barges running north and south from Grand Forks.

The following is a statement of the freight moved in 1892:

| | Tons. |
|---|---|
| To Grand Forks, N. Dak,, from the north and south— | |
| Wheat | 10,960 |
| Wood | 2,625 |
| From Grand Forks, N. Dak., to the north and south: | |
| Merchandise | 211 |
| Lumber | 460 |
| Total | 14,256 |

About 1,500,000 feet, B. M., of saw logs were floated down the river from Red Lake River to beyond the boundary line in August.

*Comparative statement of freight moved by barges and steamboats during the past fourteen years.*

| Year. | Tons. | Year. | Tons. | Year. | Tons. |
|---|---|---|---|---|---|
| 1892 | 14,256 | 1887 | 10,405 | 1882 | 31,652 |
| 1891 | 12,137 | 1886 | 10,507 | 1881 | 26,557 |
| 1890 | 1,710 | 1885 | 23,043 | 1880 | 21,651 |
| 1889 | 3,866 | 1884 | 29,046 | 1879 | 17,839 |
| 1888 | 12,140 | 1883 | 25,314 | | |

## A A 7.

### SURVEYS FOR RESERVOIRS AT SOURCES OF MISSISSIPPI, ST. CROIX, CHIPPEWA, AND WISCONSIN RIVERS.

Nothing was done under this head during the past fiscal year, no funds having been available for such work. For account in detail of these surveys, reference is made to pages 1507 and 1508, Appendix Y, Part II, Annual Report of Chief of Engineers, 1886.

It has been demonstrated that the reservoir system at the sources of the Mississippi River increases the navigable capacity of the Mississippi River at Saint Paul at least 1 foot during low-water seasons. It is simply a question of more or less water collected as to whether the improvement shall be more or less than that. More water must of necessity improve a river for navigable purposes; and hence I think it advisable to see whether the great collecting capacity of the watershed of the Crow Wing River can not be added to the present supply at a reasonable cost. It is therefore recommended that the sum of $5,000 be expended in making an examination and survey of the basin of Crow Wing River and Gull Lake with a view to determine whether its waters can be added to the reservoir system at a reasonable cost.

It is to be particularly noted that although the steamboat navigation above Minneapolis is, at present, insignificant, the time is pretty sure to come when it will be important; and furthermore there is to-day an enormous commerce upon these waters. The great mass of floating logs is nothing more nor less than a commercial product being moved to market by the cheapest known form of transportation. The actual annual tonnage of products of the forest thus moved to market is considerably in excess of 1,000,000 tons, and the tonnage is rapidly increasing.

This is a commerce worthy of attention and consideration.

*Money statement.*

| | |
|---|---|
| Amount (estimated) required for completion of existing project | $50,000.00 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895 | 5,000.00 |
| Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893. | |

## A A 8.

## GAUGING MISSISSIPPI RIVER AT OR NEAR ST. PAUL, MINN.

The Board of Engineers, to whom was referred the project for the application of $37,500 appropriated by the river and harbor act of August 5, 1886, for reservoirs at the headwaters of Mississippi River, recommended, in their report dated May 24, 1887:

> That such gaugings be made at or near St. Paul during the annual operations of the reservoirs as shall determine accurately the discharge at that point during critical periods. (P. 1692, Annual Report Chief of Engineers, 1887.)

The river and harbor act of August 11, 1888, authorized the gaugings and provided for them as follows:

> And the Secretary of War shall cause such gaugings to be made at or near St. Paul during the annual operation of said reservoirs as shall determine accurately the discharge at that point, the cost of the same to be paid out of the annual appropriation for gauging the waters of the Mississippi River and its tributaries.
>
> * * * * * * *
>
> SEC. 6. That for the purpose of securing the uninterrupted gauging of the waters of the Lower Mississippi River and its tributaries, as provided for in joint resolution of the 21st of February, 1871, upon the application of the Chief of Engineers, the Secretary of War is hereby authorized to draw his warrant or requisition from time to time upon the Secretary of the Treasury for such sums as may be necessary to do such work, not to exceed in the aggregate for each year the amount appropriated in this act for such purpose: *Provided, however,* That an itemized statement of said expenses shall accompany the Annual Report of the Chief of Engineers.

Gaugings were not made until the fall of 1889, although an allotment of $900 for the fiscal year ending June 30, 1889, had been made. On account of the lateness of the season and the condition of the river it was not deemed advisable to expend any of the money that year.

The allotments of $600, $900, $900, and $500 made for the fiscal years 1889–'90, 1890–'91, 1891–'92, and 1892–'93, respectively, were applied to gauging the Mississippi River at St. Paul.

During the past year a total of eighty-seven gaugings have been made, as follows:

*Table of gaugings made at St. Paul, Minn., during the fiscal year ending June 30, 1893.*

[Mississippi River at Robert Street Bridge. Method: Ellis current meter No. 21.]

| No. | Date. | Reading of signal service gauge St. Paul, Minn. | Discharge per second. | Remarks. |
|---|---|---|---|---|
| | 1892. | | *Cubic feet.* | |
| 1 | July 1 | 8.3 | 22,787.89 | |
| 2 | July 5 | 6.9 | 17,740.87 | |
| 3 | July 6 | 6.8 | 17,096.99 | |
| 4 | July 7 | 6.6 | 15,811.63 | |
| 5 | July 9 | 5.9 | 14,239.62 | |
| 6 | July 11 | 5.5 | 12,574.03 | |
| 7 | July 12 | 5.3 | 11,336.19 | |
| 8 | July 13 | 5.0 | 10,622.92 | |
| 9 | July 15 | 4.7 | 9,472.32 | Wind downstream. |
| 10 | July 16 | 4.45 | 9,257.89 | |
| 11 | July 18 | 4.85 | 9,852.20 | |
| 12 | July 19 | 4.95 | 10.534.79 | |
| 13 | July 20 | 5.0 | 11,099.52 | |
| 14 | July 21 | 5.1 | 11,040.32 | Do. |
| 15 | July 22 | 5.2 | 11,782.46 | |
| 16 | July 23 | 5.05 | 11,397.11 | Breeze downstream. |
| 17 | July 25 | 5.0 | 10,585.96 | |
| 18 | July 26 | 4.95 | 10,266.60 | |
| 19 | July 27 | 6.42 | 15,686.07 | |
| 20 | July 28 | 6.7 | 17,057.45 | |
| 21 | July 29 | 6.45 | 15,728.74 | |
| 22 | July 30 | 6.43 | 15,833.04 | |
| 23 | Aug. 1 | 6.35 | 15,672.34 | |
| 24 | Aug. 2 | 6.2 | 14,459.69 | Do. |
| 25 | Aug. 3 | 6.00 | 14,131.98 | |
| 26 | Aug. 4 | 5.8 | 13,296.13 | |
| 27 | Aug. 5 | 5.7 | 12,885.71 | |
| 28 | Aug. 6 | 5.49 | 12,329.68 | |

*Table of gaugings made at St. Paul, Minn., during the fiscal year ending June 30, 1893.*

[Mississippi River at Robert Street Bridge. Method: Ellis current meter No. 21.]

| No. | Date. | Reading of signal service gauge St. Paul, Minn. | Discharge per second. | Remarks. | No. | Date. | Reading of signal service gauge St. Paul, Minn. | Discharge per second. | Remarks. |
|---|---|---|---|---|---|---|---|---|---|
| | 1892. | | *Cubic feet.* | | | 1892. | | *Cubic feet.* | |
| 29 | Aug. 8 | 5.4 | 11,740.57 | Rain. | 61 | Oct. 18 | 2.72 | 6,060.55 | Breeze down stream. |
| 30 | Aug. 9 | 5.3 | 11,486.61 | | | | | | |
| 31 | Aug. 10 | 5.2 | 10,744.22 | | 62 | Oct. 19 | 2.62 | 5,623.11 | |
| 32 | Aug. 11 | 4.9 | 9,952.52 | | | 1893. | | | |
| 33 | Aug. 12 | 4.8 | 9,956.05 | | 63 | June 2 | 9.07 | 27,635.5 | |
| 34 | Aug. 15 | 4.65 | 10,053.03 | Wind downstream. | 64 | June 3 | 8.85 | 25,270.2 | |
| | | | | | 65 | June 5 | 8.37 | 24,050.7 | |
| 35 | Aug. 19 | 4.05 | 8,600.74 | | 66 | June 6 | 8.12 | 23,589.6 | |
| 36 | Aug. 20 | 3.92 | 8,028.56 | | 67 | June 7 | 7.92 | 22,366.4 | |
| 37 | Aug. 22 | 3.7 | 7,744.40 | | 68 | June 8 | 7.67 | 21,072.6 | |
| 38 | Aug. 23 | 3.7 | 7,886.47 | Do. | 69 | June 9 | 7.4 | 20,051.8 | |
| 39 | Aug. 24 | 3.6 | 7,383.67 | Breeze upstream. | 70 | June 10 | 7.22 | 18,828.1 | |
| 40 | Sept. 8 | 3.6 | 7,607.10 | | 71 | June 12 | 6.82 | 17,717.5 | |
| 41 | Sept. 10 | 3.8 | 8,157.80 | | 72 | June 13 | 6.57 | 16,238.7 | |
| 42 | Sept. 13 | 4.2 | 9,269.91 | | 73 | June 14 | 6.3 | 15,167.7 | Strong wind down. |
| 43 | Sept. 15 | 3.95 | 8,296.87 | | | | | | |
| 44 | Sept. 17 | 3.6 | 7,566.98 | Wind down stream. | 74 | June 15 | 6.1 | 15,069 | |
| | | | | | 75 | June 16 | 5.9 | 14,090.2 | |
| 45 | Sept. 20 | 3.3 | 6,904.45 | | 76 | June 17 | 5.8 | 13,247 | |
| 46 | Sept. 22 | 3.32 | 7,005.10 | | 77 | June 19 | 5.35 | 12,187.5 | Strong breeze down stream. |
| 47 | Sept. 23 | 3.3 | 6,904.99 | | | | | | |
| 48 | Sept. 24 | 3.3 | 6,881.07 | | 78 | June 20 | 5.27 | 11,594.7 | |
| 49 | Sept. 26 | 3.05 | 6,784.23 | Do. | 79 | June 21 | 5.23 | 11,617.3 | Do. |
| 50 | Sept. 27 | 3.00 | 6,465.05 | Do. | 80 | June 22 | 5.00 | 10,033.2 | |
| 51 | Sept. 28 | 2.9 | 6,546.91 | Do. | 81 | June 23 | 4.92 | 10,079.2 | Strong breeze upstream. |
| 52 | Sept. 29 | 3.1 | 6,668.81 | Do. | | | | | |
| 53 | Sept. 30 | 3.2 | 6,654.85 | | 82 | June 24 | 4.8 | 9,910.2 | |
| 54 | Oct. 1 | 3.2 | 6,812.27 | Do. | 83 | June 26 | 4.75 | 9,604.1 | |
| 55 | Oct. 4 | 3.05 | 6,618.67 | Windy. | 84 | June 27 | 4.75 | 9,829.5 | |
| 56 | Oct. 6 | 3.02 | 6,482.84 | | 85 | June 28 | 4.72 | 9,256.4 | Strong breeze upstream. |
| 57 | Oct. 8 | 2.9 | 6,308.28 | | | | | | |
| 58 | Oct. 11 | 2.9 | 6,363.10 | | 86 | June 29 | 4.55 | 9,407.8 | Strong breeze down stream. |
| 59 | Oct. 12 | 2.8 | 6,116.26 | | | | | | |
| 60 | Oct. 15 | 2.72 | 5,929.64 | | 87 | June 30 | 4.42 | 8,716.5 | |

The gaugings were made by observing the mid-depth velocities in sections 20 feet apart. Mean velocity was taken as 95 per cent of mid-depth velocity.

The results of the gaugings are interesting and valuable so far as they go, but I desire to repeat the recommendation contained in previous annual reports that the money heretofore allotted and made available for gaugings has been inadequate to procure the information needed for a correct and scientific investigation of the effect of the reservoir water on the Mississippi River. It is imperative that this effect shall be ascertained and established beyond question. The knowledge gained would be of use not only in connection with the present reservoir system at the headwaters of the Mississippi River, but also in determining the value of reservoirs as a means of improving rivers in general.

It is recommended that Congress be asked to fix the amount to be annually available for this specific work.

Amount expended during the fiscal year ending June 30, 1893, including outstanding liabilities, $500.

*Abstract of allotments.*

For fiscal year ending June 30—

| | |
|---|---|
| 1889 | *$900 |
| 1890 | 600 |
| 1891 | 900 |
| 1892 | 900 |
| 1893 | 500 |

## *Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $45.22 |
| Amount allotted for fiscal year ending June 30, 1893 | 500.00 |
| | 545.22 |
| June 30, 1893, amount expended during fiscal year | 431.23 |
| July 1, 1893, balance unexpended | 113.99 |
| July 1, 1893, outstanding liabilities | 113.99 |
| Amount allotted for fiscal year ending June 30, 1894 | 500.00 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895 | 4,600.00 |
| Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893. | |

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*Itemized statement of expenditures during the fiscal year ending June 30, 1893*

| Date. | To whom paid. | For what paid. | Amount. |
|---|---|---|---|
| 1892. | | | |
| Aug. 1 | Sundry persons | Pay roll, July | $235.00 |
| Aug. 11 | Robinson, Cary & Co | Wire rope, etc | 64.87 |
| Nov. 29 | Ames, Ebert & Co | Dry batteries | 2.00 |
| Dec. 19 | Boeringer & Son | Repairs | 1.35 |
| Dec. 19 | St. Croix Lumber Co | Lumber | .90 |
| 1893. | | | |
| Jan. 20 | John E. Dempsey | Office blanks | 3.50 |
| Apr. 27 | Robinson, Cary & Co | Okanite | 1.74 |
| May 18 | George Müller | Skiff and oars | 38.40 |
| June 12 | Sundry persons | Pay roll, May | 38.25 |
| | Total | | 386.01 |

*Outstanding liabilities to June 30, 1893.*

| To whom owing. | On account of— | Amount. |
|---|---|---|
| M. McNulty | Drayage | $0.50 |
| H. D. Toner | ......do | .50 |
| St. Paul and St. Croix Packet Co | Towing | 2.00 |
| Robinson, Cary & Co | Wire rope, etc | 104.08 |
| Boeringer & Son | Brass tags, etc | 1.65 |
| F. J. Rens | Repairs to meter | 3.25 |
| St. Paul Hardware Co | Chain | .50 |
| Beacon Electric Co | Wire | .21 |
| H. E. Wedelsteadt & Co | Paper and rubber stamp | 1.30 |
| Total | | 113.99 |
| Expended during the fiscal year ending June 30, 1893 | | 386.01 |
| Total | | 500.00 |

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* Not used.

# APPENDIX B B.

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## REPORT OF LIEUT. COL. CHARLES R. SUTER, CORPS OF ENGINEERS, UPON PRELIMINARY EXAMINATION OF KANSAS RIVER, KANSAS.

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[Printed in House Ex. No. 243, Fifty-second Congress, second session.]

### LETTER OF THE CHIEF OF ENGINEERS.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
*Washington, D. C., February 13, 1893.*

SIR: I have the honor to submit herewith a copy of report, dated February 9, 1893, upon preliminary examination of Kansas River, Kansas, made by Lieut. Col. Charles R. Suter, Corps of Engineers, in compliance with provisions of river and harbor act approved July 13, 1892.

It is the opinion of Colonel Suter, in which I concur, that Kansas River is not at the present time worthy of improvement by the General Government.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
*Brig. Gen., Chief of Engineers.*

Hon. S. B. ELKINS,
*Secretary of War.*

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### REPORT OF LIEUT. COL. CHARLES R. SUTER, CORPS OF ENGINEERS.

MISSOURI RIVER COMMISSION,
OFFICE OF THE PRESIDENT,
*St. Louis, Mo., February 9, 1893.*

GENERAL: I beg leave to submit herewith a report upon a preliminary examination of the Kansas River, assigned to me by your orders of July 14, 1892.

As an examination of this stream was made under my direction in 1879, in sufficient detail to furnish the required information regarding the physical characteristics of the stream, no field work has been deemed necessary (see H. R. Ex. Doc. No. 94, Forty-fifth Congress, third session). I have, however, endeavored to ascertain from all known sources what interests are at present concerned in the improvement of the river.

The Kansas, or Kaw, River is formed by the junction of the Republican and Smoky Hill rivers, and its course is entirely within the State of Kansas. Its length from the junction mentioned to its confluence with the Missouri at Kansas City is approximately 176 miles. In this distance its fall at low water is 326 feet, giving an average slope of 1.85 feet per mile. This is considerably exceeded in some portions, slopes of 2½ feet per mile being noted. The low-water discharge of the stream is about 2,000 cubic feet per second at ordinary low water. What it may be at extreme low stages is not known. The high-water discharge is estimated at 100,000 cubic feet per second, and it may at times be even more. The range from high to low water is about 16 feet. Like all streams with an extensive watershed, composed mostly of open prairie land, the floods on the Kaw are violent but of quite short duration. The periods of low water are long; in fact, this may be fairly considered the normal condition of the stream.

The natural obstructions to navigation, besides shoal water, are numerous snags and in some few localities rock ledges and bowlders. The artificial obstructions are numerous low bridges, all unprovided with draws, and the milldam at Lawrence. In 1879 there were nine of these bridges. The number at present is not known, but must be much greater. In 1879 there were two bridges within 5 miles of the mouth; there are now thirteen in the same distance. The low-water depth from the mouth to Topeka, 74 miles, available for navigation is about 12 inches; above that point about 6 inches. The bars are of sand, constantly shifting in position, and the banks are easily eroded, thereby constantly adding to the supply of snags.

In early days this river was navigated. Just when navigation ceased I have not been able to find out, but it probably followed the construction of the Kansas Pacific Railroad and the dam at Lawrence. In 1864 the State legislature of Kansas declared the stream unnavigable, and authorized bridges to be built over it and dams to be constructed as on any other unnavigable stream. This law has not been sustained by the United States courts, but the bridges have been built nevertheless, as before stated.

When the report of 1879 was submitted it was thought that a substantial improvement by means of contraction works was possible. * * * Costly experience at home and abroad obtained since that date has, however, convinced me that an open river improvement on a stream of such high slope and small volume is impossible, and that canalization, with locks and either fixed or movable dams, would be the only feasible method. The cost of such an improvement would be very great, and when added to the cost of altering all the existing bridges would run up into figures which would not be justified by any possible benefit that could be conferred at the present time. From all that I can ascertain, a desire to reduce railroad rates by introducing water competition is the basis of the present movement. Bearing in mind that the distance by river is only 176 miles, by land 135 miles, and that there is practically a continuous line of railroad on both banks, it will be seen that nothing but extraordinarily favorable conditions of navigation would render such competition possible.

These conditions do not exist naturally, and could only be supplied artificially at great cost. In any case, as long as the Missouri can not be profitably navigated as far up as Kansas City, it would seem useless to expend money on a tributary entering above that point. After the Missouri, below the junction of the Kansas River, has been improved to such an extent that through water transportation can be given, it is possible that the case may present a different aspect; but as it now stands I am compelled to state that in my opinion the Kansas River is not, at the present time, worthy of improvement by the General Government.

Very respectfully, your obedient servant,

CHAS. R. SUTER,
*Lieut. Col. of Engineers, U. S. A.,*
*President Missouri River Commission.*

Brig. Gen. THOMAS L. CASEY,
*Chief of Engineers, U. S. A.*

# APPENDIX C C.

## IMPROVEMENT OF MISSOURI RIVER ABOVE SIOUX CITY, IOWA, AND OF YELLOWSTONE RIVER, MONTANA AND NORTH DAKOTA.

*REPORT OF CAPT. H. F. HODGES, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1893, WITH OTHER DOCUMENTS RELATING TO THE WORKS.*

### IMPROVEMENTS.

1. Missouri River between the Great Falls, Montana, and Sioux City, Iowa.
2. Removal of snags and other obstructions in Missouri River above Sioux City, Iowa.
3. Examination of Missouri River between Three Forks and Canyon Ferry, Mont., to determine availability of water power.
4. Yellowstone River, Montana and North Dakota.

### EXAMINATION.

5. James River, South Dakota.

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ENGINEER OFFICE, U. S. ARMY,
*Sioux City, Iowa, July 10, 1893.*

GENERAL: I have the honor to transmit herewith reports upon the works in my charge for the year ending June 30, 1893.

Very respectfully, your obedient servant,

H. F. HODGES,
*Captain, Corps of Engineers.*

Brig. Gen. THOMAS L. CASEY,
*Chief of Engineers, U. S. A.*

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## C C 1.

## IMPROVEMENT OF MISSOURI RIVER BETWEEN THE GREAT FALLS, MONTANA, AND SIOUX CITY, IOWA.

### APPROVED PROJECT.

From the Great Falls to Fort Benton the Missouri river is so much obstructed and has so steep a slope that no improvement for purposes of navigation seems practicable and none has ever been attempted. Between Fort Benton and Carroll, 168 miles below, the stream has a rocky and gravelly bed, a clear water and naturally stable banks. The project for the improvement of this stretch contemplates removal of rocks, construction of closing and wing dams, and some dredging. This project is assumed to date from the appropriation of 1882; the total estimate for its completion is $556,028.45. Previous to its adoption a sum of $157,263 had been spent on the river above the Yellowstone.

At Carroll the bed of the river becomes sandy and finally, near the Dry Fork, 330 miles below Fort Benton, the stream assumes the characteristics of the lower reaches, having unstable banks, muddy water, and a shifting channel. No comprehensive project has yet been formed for the improvement of the river between Carroll and Sioux City. For this distance the work is limited to the removal of obstructions, sluicing channels at bad bars, and making a detailed survey with the collection of data necessary for the preparation of a general project. An ice harbor is also projected at Rockhaven, N. Dak.

### APPROPRIATIONS.

The appropriations for the river above Sioux City have been as follows:

| | | | |
|---|---|---|---|
| 1876 | $20,000 | 1882 | $100,000 |
| 1878 | 30,000 | 1884 | 140,000 |
| 1879 | 50,000 | 1886 | 60,000 |
| 1880 | 35,000 | 1890 | 300,000 |
| 1881 | 55,000 | 1892 | 150,000 |

For survey prior to 1884, $73,791.55.

In addition to the above a sum of $1,000,000 was appropriated in 1888 for the river from Fort Benton to the mouth, of which $50,000 was allotted to the part above Sioux City; and in 1893 a sum of $50,000 was appropriated in the sundry civil bill, to be expended for removal of snags and other obstructions above Sioux City.

### CONDITION AT BEGINNING OF YEAR.

At the beginning of the fiscal year the condition of the work was as follows:

On the Rocky River, from Fort Benton to Carroll, the most needed contraction works had been built and the most dangerous bowlders removed. Some dredging had also been done, and a navigable depth of 30 inches at low water obtained for the greater part of the reach, the worst remaining shoals showing a low-water depth of 18 inches. The plant was laid up at Judith and the work on this part of the river suspended. On the Sandy River from Carroll to Sioux City no work of construction was in progress. The site of one of the ice harbors mentioned in the river and harbor act of July 13, 1892, had been fixed at Rockhaven, N. Dak. The selection of the site for the other had been left in abeyance by direction of the War Department. Plans for the construction of the harbor at Rockhaven had been partly prepared.

Two snag boats and one snag scow were at work removing obstructions.

The field work of the detailed survey of the river was in different stages of completion. The leveling and the topography between the bluffs was complete as far as Fairbank, S. Dak. The tertiary triangulation, the short-line topography, and the hydrography were complete to below Cannonball, N. Dak. The secondary triangulation was complete. The plotting of 62 of the detailed charts was finished, extending this part of the work to Wolfpoint, Mont. Fifty-nine others were partially finished. Fifty of the finished charts were in the hands of the printer. One small scale chart was finished and ten others partially finished.

### OPERATIONS DURING THE YEAR.

During the year ending June 30, 1893, the progress of the work has been as follows:

On the Rocky River operations have been confined to the repair of plant. There still remains much work to complete the project, but it has been thought advisable to suspend further operations until there seems greater probability of a revival of boating on this reach. The dredge which had been used here was destroyed by fire on July 31, 1892. On the Sandy River no construction work has been undertaken under the present project. The plans for the ice harbor have been completed, and it is hoped to do the greater part of the work during the next low water. The snagging fleet has been at work on the river from just above Berthold to Sioux City. The wooden hulled snag boat *Josephine* was at work during the entire low water until the close of the season of 1892. She was then hauled out on ways at Yankton, S. Dak., and thoroughly repaired, the bow being altered to a shape more suitable for snagging purposes. The repairs were finished in June, 1893, and the boat is now at Sioux City waiting until the river falls sufficiently to permit work. The steel hulled snag boat *McPherson* was at work during the entire low water until the close of the season of 1892, and from April 23 to June 30, 1893. Owing to lack of available funds the steel hulled snag scow *Mandan*, did not commence work until September 16, 1892. She continued until the close of the season, and was then put on the ways at Yankton, S. Dak. The hull has been lengthened and preparations made to fit her with steam power. She was launched on June 15 and towed to Sioux City, where the changes are now in progress.

A summary of the work of the boats is as follows:

| Boats. | Removed or destroyed— | |
|---|---|---|
| | Snags. | Miscellaneous obstructions. |
| Josephine | 224 | 13 |
| McPherson | 386 | 32 |
| Mandan | 74 | 8 |

In addition various channels were sluiced at bad bars, assistance was rendered to vessels when aground, and the machinery was removed from a wreck.

Two large rocks, which were notable as having caused the loss of the *Pocahontas* and the sinking of the *Lady Grace*, as well as the damage of several other boats, were taken out by the *McPherson*. They weighed 13½ and 10 tons respectively.

In the survey of the Missouri River the field work has been carried forward until it is now nearly finished. The primary leveling has been finished in duplicate from Fairbank to Chamberlain, and a single line has been completed to Sioux City. The tertiary triangulation, shore-line topography, and hydrography has been taken from below the Cannonball

River to Sioux City, with the exception of a gap of about 20 miles between Crow Creek and Chamberlain. The topography between the bluffs has been carried from Fairbank to Yankton. To complete the field work there remains to run a duplicate line of primary levels from Chamberlain to Sioux City, to take the topography between the bluffs from Yankton to Sioux City, and to take the tertiary triangulation, shore line topography, and hydrography from Crow Creek to Chamberlain; and to make such discharge measurements as may be deemed necessary. Fifty-nine detail charts have been practically finished and sixty-nine new charts partially finished. The large scale maps are now finished from Fort Benton to Cannonball, 885 miles, and the remaining 598 miles of river are about one-third plotted. Eight small scale maps have been finished during the year and another one about half done. About one-third of this part of the work is now finished. Editions of thirteen of the detail charts have been received from the printer.

## WORK REQUIRED.

To complete the existing project on the Rocky River will require an expenditure of $190,097.84. A sum of $12,905.15 is still on hand from previous appropriations and reserved for use on this part of the river. It will suffice for such operations as are probable for the year ending June 30, 1895. It is expected to complete the ice harbor, the survey and the publication of charts from funds now in hand for those purposes. The appropriation of $50,000 contained in the sundry civil bill of 1893, for the removal of snags, etc., will suffice for the operation of the snagging fleet until June 30, 1894.

The work of the snag boats is of more service than any other possible with the same expenditure of money. It will remain necessary until the channel has been permanently fixed. So long as the river is allowed to shift and cut its banks as it now does it will continue to uncover buried obstructions and to cause new ones. So important and indispensable a work should not be left to the hazard of annual appropriations. The recommendation of last year is renewed, that the least estimate, $50,000 per annum for the removal of snags and other obstructions and for temporary improvement at the shoalest channels, be made as a separate and continuous appropriation. This was done in the case of the Upper Mississippi and the Ohio rivers in the river and harbor acts of 1888 and 1890.

The appropriation estimated as needed for the year ending June 30, 1895, is $1,127,000. This is to be expended as follows:

| | |
|---|---|
| Rectification of river at Pierre and Fort Pierre | $150,000 |
| One-half rectification of and permanent channel improvement of 25 miles of Bismarck Reach | 198,000 |
| One-fourth rectification and permanent channel improvement of Yankton-Sioux City Reach, 130 miles | 514,000 |
| Plant and maintenance for one year | 210,000 |
| Maintenance of ice harbor for one year | 5,000 |
| Operating snag boats for one year | 50,000 |
| Total | 1,127,000 |

The last item for the snag boats is asked in case it fail to be made as a continuous appropriation. In case authority can not be obtained for the work of rectification and permanent channel improvement, there remain the works at Pierre and Yankton, which were named in the appropriation act of 1892, but which have not been undertaken as the amount appropriated was not sufficient to do the work already projected and leave a sufficient margin to attempt such extensive diking and bank protection. The permanent improvements proposed for the two reaches referred to above are for the purpose of straightening, deepening, and fixing the channel at the points where ice gorges are most liable to form, at certain bad places on the river, and at important towns where it is desirable to preserve the landings endangered by shifting of the channel.

*Money statement.*

| | | |
|---|---|---|
| July 1, 1892, balance unexpended | | $110,986.81 |
| Amount received by refundment of overpayment | | 41.60 |
| Amount appropriated by act approved July 13, 1892 | | 150,000.00 |
| | | 261,028.41 |
| June 30, 1893, amount expended during fiscal year | | 100,900.94 |
| July 1, 1893, balance unexpended | | 160,127.47 |
| July 1, 1893, outstanding liabilities | $9,725.00 | |
| July 1, 1893, amount covered by uncompleted contracts | 13,775.00 | |
| | | 23,500.00 |
| July 1, 1893, balance available | | 136,627.47 |
| Amount (estimated) required for completion of existing project[*] | | 135,000.00 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895[*] | | 1,077,000.00 |
| Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893. | | |

COMMERCIAL STATISTICS.

*River tonnage between Sioux City, Iowa, and Fort Benton, Mont. (exclusive of live stock).*

| | Tons. | | Tons. |
|---|---|---|---|
| 1887 | 13,961 | 1890 | 13,326 |
| 1888 | 12,895 | 1891 | 13,055 |
| 1889 | 16,724 | 1892 | 15,182 |

*Traffic by river reaches.*

| Year. | River reaches between— | Package and bulk freight. | Passengers. | Live stock. |
|---|---|---|---|---|
| | | *Tons.* | *No.* | *Head.* |
| 1890 | Sioux City and Bismarck | 9,735 | 4,322 | 2,974 |
| | Bismarck and Fort Buford | 2,467 | 184 | 43 |
| | Fort Buford and Fort Benton | 1,124 | 62 | 43 |
| 1891 | Sioux City and Bismarck | 10,410 | 1,749 | 4,683 |
| | Bismarck and Fort Buford | 2,645 | 130 | 59 |
| 1892 | Sioux City and Pierre | 2,634 | 32 | 6,043 |
| | Pierre and Bismarck | 7,247 | 177 | 2,315 |
| | Bismarck and Fort Buford | 5,301 | 278 | 300 |

[*] Exclusive of $50,000 annually for removal of snags, etc.

*List of steamers plying on the Missouri River between Sioux City, Iowa, and Fort Benton, Mont., during the year 1892.*

| Name. | When built. | Dimensions. | | | Tonnage. | Manager or owner. |
|---|---|---|---|---|---|---|
| | | Length. | Breadth. | Depth. | | |
| | | *Feet.* | *Feet.* | *Feet.* | | |
| A. S. Bennett | 1880 | 115.0 | 30.0 | 3.5 | 78.08 | R. A. Talbot, Sioux City, Iowa. |
| Mary E. Bonnett | 1888 | 65.0 | 14.0 | 2.0 | 21.71 | R. A. Talbot, Sioux City, Iowa. |
| Capitola Butt | 1885 | 83.7 | 23.3 | 3.3 | 57.31 | E. A. Conway, Sioux City, Iowa. |
| Vint Stillings | 1881 | 131.0 | 31.6 | 4.8 | 177.47 | Selzer Bros., Sioux City, Iowa. |
| Josie L. K | 1884 | 60.0 | 14.0 | 2.5 | 22.75 | A. Larsen, Yankton, S. Dak. |
| Little Maud: | 1882 | 92.0 | 20.0 | 3.4 | 58.66 | Jos. Leach, Running Water, S. Dak. |
| Last Chance | 1870 | 98.2 | 17.8 | 3.0 | 50.47 | M. J. King, Chamberlain, S. Dak. |
| Jas, Leighton | | | | | 57.29 | F. Horn, Pierre, S. Dak. |
| Castalia | 1892 | | | | 75.00 | B. S. Holmes, Sioux City, Iowa. |
| Batchelor | | 178.6 | 31.0 | 4.0 | 313.00 | I. P. Baker, Bismarck, N. Dak. |
| Rosebud | 1887 | 177.4 | 31.3 | 4.0 | 286.49 | I. P. Baker, Bismarck, N. Dak. |
| Imelda | | | | | 15.00 | D. B. Weatherbe, Fort Yates, N. Dak. |
| Abner O'Neal* | 1884 | 150.0 | 28.4 | 8.8 | 197.74 | John M. Turner, Mandan. N. Dak. |

* Sunk July 17, 1892, and since dismantled.

### LETTER FROM MR. JOHN M. TURNER, PRESIDENT OF THE MISSOURI RIVER TRANSPORTATION COMPANY.

MANDAN, N. DAK., *April 10, 1893.*

CAPTAIN: I inclose herewith reports as requested. We did a large business last year but had the misfortune to lose our boat near Painted Woods by striking a snag. There is a large amount of business to be done on the river above Bismarck if the river was in navigable condition at all times, but the dangers of navigation are so great that it will not pay to put on boats to build up the business and accommodate the settlers. The crop of wheat for two years is still practically held by farmers near Knife River, owing to lack of boat facilities.

Very respectfully,

JOHN M. TURNER,
*President.*

### LETTER FROM MR. E. L. SENN, SECRETARY PEASE VALLEY TRANSPORTATION COMPANY.

SIOUX CITY, IOWA, *April 10, 1893.*

CAPTAIN: We made but one trip last year, just before navigation closed. We are now about to begin the season's work, and will handle 150 to 200 tons of freight every ten days.

The snag boats can be of great service by removing snags from narrow places in the channel, which are frequently so obstructed as to make passage extremely difficult and hazardous.

Our company is now planning to put on a 200-ton boat in time for harvest trade; in all probability we will have several boats before season closes.

Yours, respectfully,

E. L. SENN,
*Secretary Pease Valley Transportation Company.*

Capt. CHAS. F. POWELL,
*Corps of Engineers, U. S. A.*

### STATEMENT OF CAPT. D. B. WEATHERBE, OWNER OF STEAMER IMELDA.

FORT YATES, N. DAK., *April 22, 1893.*

CAPTAIN: I have not the time at present to make a proper report of any improvements that might be made in Missouri River, but would say that the recent work that was done by the *Mandan* was a great benefit to navigation between this point and Bismarck. But this spring there are a great many new snags in the river between here and Bismarck; also, there is a very dangerous snag right in front of the landing at this post. The snag lies in the channel and makes it very difficult for the boats landing. I think there ought to be some notice taken of it, as there is more freight landed at this point than all the other points on the river from Sioux City to Benton.

D. B. WEATHERBE.

Capt. CHAS. F. POWELL,
*Sioux City, Iowa.*

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## LETTER FROM MR. M. T. WOLVERTON, SECRETARY CAMPBELL ROLLER MILL COMPANY.

CAMPBELL, S. DAK., *April 24, 1893.*

CAPTAIN: Having our Roller Mill Company organized, and having entered into a contract with Nordyke & Mormon, of Indianapolis, Ind., for a first-class roller mill, which is to be erected here at Campbell this summer, I am instructed to write you and learn what the prospect is for work on the river. Will your funds allow of any bank work at this point? We desire to have the mill built close to the river for convenience in getting coal for mill use and sale and for shipping flour and wheat. We will also build an elevator this fall if we can do so without danger of the banks giving away and letting it into the river. It is so far from railway market that we are compelled to ship by river or give up wheat raising. Please send me a copy of your last report on Missouri River Improvement.

Hoping to hear from you soon, I remain, yours truly,

M. T. WOLVERTON,
*Campbell Roller Mill Company.*

Capt. CHAS. F. POWELL,
*Corps of Engineers, U. S. A.*

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*Dates of ice closings and openings on the Missouri River above Sioux City, Iowa.*

[Continued and extended from page 3392, Report for 1890; previous tables on page 1349, Report for 1883, and page 2345, Report for 1888.]

| Locality. | 1890-'91. | | 1891-'92. | | 1892-'93. | |
|---|---|---|---|---|---|---|
| | Closing. | Opening. | Closing. | Opening. | Closing. | Opening. |
| MONTANA. | | | | | | |
| Townsend | | | Dec. 24 | Feb. 24 | Dec. 21 | Mar. 21-23. |
| Fort Benton | Feb. 1 | Mar. 20 | Dec. 26<br>Feb. 15 | Feb. 7<br>Feb. 24 | Nov. 24<br>Jan. 25 | Jan. 3.<br>Mar. 9-11. |
| Judith | | | Nov. 16<br>Dec. 25 | Nov. 26<br>Mar. 10 | Nov. 23 | Apr. 5. |
| Wolf Point | | | Nov. 12 | Mar. 29-Apr. 1 | Nov. 20 | Apr. 1-7. |
| NORTH DAKOTA. | | | | | | |
| Fort Buford | Dec. 4 | Mar. 29 | Nov. 16 | Apr. 4 | Nov. 24 | Apr. 2-6. |
| Bismarck | Dec. 3 | Apr. 3-4 | Nov. 15 | Apr. 3-5 | Nov. 21 | Apr. 3-8. |
| SOUTH DAKOTA. | | | | | | |
| Pierre | | | | Mar. 28 | | |
| Chamberlain | | | | Mar. 27-28 | Nov. 26 | |
| Running Water | | | | | Nov. 23 | Mar. 11. |
| Yankton | | | | | Nov. 25 | Mar. 29-30. |
| IOWA. | | | | | | |
| Sioux City | Jan. 4 | Mar. 31 | Nov. 25<br>Dec. 25 | Dec. 13<br>Mar. 5-25 | Dec. 17 | Mar. 13-30. |

NOTE.—The single dates of openings are the times when the ice first moves out; generally the ice runs for several days afterwards. The expressions like "Apr. 3-5" indicate that the ice breaks up on the first date and runs more or less until the last date, when the river would be open for navigation.

*Table of distances from river survey, 1892.*

[By United States Engineers.]

| Places. | Channel line. | Midway between banks. | Places. | Channel line. | Midway between banks. |
|---|---|---|---|---|---|
| | *Miles.* | *Miles.* | | *Miles.* | *Miles.* |
| Fort Benton Bridge | .0 | .0 | Head of Devils Island | 1,048.0 | 998.2 |
| Mouth of Cannonball River, North Dakota | 886.0 | 841.4 | Little Bend (bight of) | 1,059.6 | 1,008.8 |
| Cannonball Mission | 888.8 | 844.1 | Mouth of Cheyenne River | 1,062.8 | 1,012.0 |
| Hampton | 890.6 | 846.0 | Head of Cheyenne Island | 1,064.6 | 1,013.6 |
| Emmonsburg | 899.6 | 855.2 | Head of Emilie Island | 1,068.4 | 1,017.4 |
| Winona | 911.3 | 866.2 | Fort Bennett | 1,072.8 | 1,022.2 |
| Fort Yates | 911.8 | 866.7 | Head of Stanley Island | 1,077.0 | 1,026.0 |
| St. Benedict Mission | 929.3 | 883.5 | Fort Sully | 1,080.7 | 1,028.8 |
| Vanderbilt, S. Dak | 932.5 | 886.6 | Okobojo Island | 1,085.4 | 1,033.8 |
| La Grace | 938.9 | 892.7 | Oahe Mission | 1,097.6 | 1,044.9 |
| Campbell | 954.8 | 907.7 | Pierre | 1,111.6 | 1,058.2 |
| Head of Ashley Island | 963.8 | 916.5 | Fort Pierre | 1,111.6 | 1,058.2 |
| Head of Blue Blanket Island | 977.2 | 929.7 | Head of Farm Island | 1,117.0 | 1,063.9 |
| Head of Fox Island | 982.4 | 934.8 | Rousseau | 1,127.1 | 1,073.0 |
| Le Beau | 994.0 | 946.4 | De Gray | 1,136.0 | 1,081.6 |
| Scranton | 996.0 | 948.4 | Head of Dorion Island | 1,142.6 | 1,087.8 |
| Forest City | 1,018.2 | 970.0 | Head of Little Dorion Island | 1,144.8 | 1,089.8 |
| Head of Dolphee Island | 1,022.0 | 973.6 | Head of St. John Island | 1,172.6 | 1,116.2 |
| Head of Pascal Island | 1,029.0 | 980.4 | Big Bend (bight of) | 1,175.0 | 1,118.0 |
| Head of Plum Island | 1,041.8 | 992.3 | Head of Cadotte Island | 1,182.1 | 1,125.0 |
| Fairbank | 1,044.2 | 994.2 | Crow Creek Indian Agency | 1,197.4 | 1,139.4 |

## DESCRIPTIVE NOTES OF THE MISSOURI RIVER AND ADJACENT COUNTRY, FROM CAMPBELL, S. DAK., TO SIOUX CITY, IOWA, BY MR. F. M. TOWAR AND MR. F. W. LIGHTNER, CHIEFS OF SURVEY PARTY OVER THAT REACH, 1892.

The river from Cannonball, N. Dak., to Campbell, S. Dak., a distance of about 70 miles, runs through a valley of from 1 to 2 miles wide between the bluffs. Very little rock formation appears on either side; the bluffs of clay and marl are, however, filled with bowlders which, becoming detached, roll down into the river, forming dangerous obstructions to low-water navigation.

Near Campbell the valley changes in two respects: First, it becomes very much more contracted, not often exceeding a mile from bluff to bluff; second, the river cuts its way through a rock formation of a slaty or shaly nature, the surface of the shale being from 30 to 50 feet above the water, and overlaid with clay or gumbo to the top of the bluffs. The course of the river is comparatively straight, with bottom lands of small extent and little or no large timber, the high water often covering the entire space between the bluffs; in low water this space is cut up into many small channels and sand bars, making navigation exceedingly difficult. This narrow valley, with the exception of a few short stretches, continues to Fort Randall, S. Dak., a distance from Campbell by river of 366 miles. In many cases examined the river has not cut a deep channel through the shale, it appearing often less than 8 feet below the low-water surface, having a shallow covering of sand frequently of not more than from 1 to 3 feet in thickness; when exposed to the air it soon disintegrates. Large lumps, becoming detached from the bluffs, roll down to the shore, crumbling into small, thin pieces that are readily carried down by the current in high water.

A short distance below Fort Randall the bottom again becomes wider, having a distance between the bluffs of from 2 to 3 miles, with a dense growth of timber on the bottom lands. At Yankton, 70 miles below Randall, it again spreads out, reaching a width of from 4 to 10 miles. The course of the river here is exceedingly crooked, winding from bluff to bluff and forming sharp bends with long reaches between them.

The immediate banks of the river between Cannonball and Sioux City are very much the same as those of all the rest of the sandy river from Dry Fork river, Montana (where the radical change between the sandy and rocky river takes place), to Cannonball, being composed in about equal parts of fine sand or silt and a hard clayey substance (commonly called gumbo) in layers. The former yields easily to the action of the current and falls into the river, while the latter offers more resistance. The degree of stability of the bank consequently depends largely on whether the silt or the gumbo forms the foundation, where the action of the water is felt; if the former, then the bank is quickly undermined, leaving no support for the harder material which tumbles into the river.

About 20 miles above Chamberlain, S. Dak., a white rock formation crops out, and from here nearly to Sioux City the bluffs are chiefly composed of it. It overlies the shale, and from its resemblance to chalk, both in appearance and substance, is called "chalk rock," and the bluffs are familiarly known as the chalk rock bluffs. The rock seems to be pure carbonate of lime with seashells and fossil remains of fish embedded in it. In this formation South Dakota and Nebraska are fortunate in possessing one of the most remarkable deposits of the crude material for making Portland cement yet discovered in this country; an inexhaustible supply of chalk rock, with large quantities of clay at hand, that makes a Portland cement an analysis of which shows that it possesses exactly the properties of the best English cements. A large cement factory has, within a few years, been established at Yankton that turns out thousands of barrels annually.

Below Yankton cut-offs are frequent, and there are indications of possible great changes in the future. The level of the bottom back of the railroad, below the town, is lower than along the present river front, and another great flood like that of 1881 might send the channel down the left side of the valley instead of the right, as at present. Another instance of future possible changes is just below the mouth of the James River about 4 miles, and opposite St. Helena; the river is rapidly cutting its way toward an old slough in the bottom, probably an old cut-off itself, which, where the river strikes it, will direct the waters out of that course for 3 or 4 miles, before returning them to their present channel again. These are all points of great interest, especially for the property owner along the river front.

It was not an uncommon thing to find men who had lost one-fourth, a one-third, or even a one-half of their farms by the high and long-continued flood of last summer. The idea of applying to the Federal Government, through their representatives, for protection in the shape of riprapping has occurred to but few of those most interested.

Down to Chamberlain the islands are not as numerous as below that place. Above this point about every 15 to 25 miles there is a good-sized, well-defined, and heavily wooded island (perhaps not so many). But below Chamberlain and down to Fort Randall the islands are very numerous and of considerable extent, from 1 to 3 miles in length, and sometimes nearly a mile wide. There are about twenty heavily wooded islands between Chamberlain and Wheeler, a distance of only 73 miles. Below the latter point they are much less frequent.

The river from Chamberlain down was comparatively free from snags, that is, as compared with the Peck Bends and that portion of the river. The operations of the snag boats have relieved the present channel of the worst obstructions of this sort, but numerous snags were necessarily left at one side in shoal water, which possibly may be in the channel next year.

But few bowlders and no ledge-rock obstructions were found. The bowlders may have been parts of the original ledge rock, but were all loose and separate.

There is an abundant supply of brush and timber for river improvements all along the river, although in some places it may have to be transported up or down stream a mile or two.

The only trouble in this line, may be in getting permission from owners of land along the river to cut on their property. I heard several property owners disclaiming against the *McPherson* for cutting down dangerous trees along the river bank.

The stretch of country from Campbell to the mouth of the Moreau or Owl River is quite productive, especially back from the river 10 or 15 miles. Lack of rain is what holds the country back. Everything is raised here in the shape of grains and garden truck.

In good seasons, wheat runs as high as 40 bushels to the acre. Last year it was only 12 to 20 bushels, on account of dry weather. The farmers say that they do not care for steamer transportation on the Missouri, as their grain goes to Duluth and Chicago. The merchants all along the river, however, would ship by steamer if only there was *certainty*.

Everybody throughout South Dakota, especially the farmers themselves, disclaim the so-called famine, stating that those who received were, as a rule, better able to give. There were "more cases of actual want in a large city."

The strip of country from the Owl River down to, practically, Chamberlain, and back eastward for 40 or 50 miles, is very poor and unproductive, being cursed with the least quantity of moisture and an abundance of the famous "hot winds."

A 30-mile ride through this country, in the vicinity of Fort Sully, showed house after house deserted and the country almost desolate. Everybody is starved out. Potter, Sully, Hughes and Buffalo counties will probably be unproductive for a number of years yet. From Chamberlain down the country increases in fertility, until Yankton and Vermillion are reached, around which towns are probably situated the finest farming lands in South Dakota. There is but little to be expected at present, however, above Charles Mix County, even if the owners cared to ship via Missouri River.

The only building stone along the river is the above-mentioned chalk rock, which is used somewhat locally, but would hardly pay to ship. It is too soft to stand a hard climate. A two-story building of this material was noticed at Yankton, just about ready to fall, and split in the middle. It was evidently an old structure, however.

At Greenwood (Yankton Agency) the Government has several good, large storehouses of chalk stone.

Very little coal was noticed opposite Ponca Landing, and on the same side of the river, however, there are three or four drifts under the hill, following a 2½-foot vein of what was claimed to be by a resident good coal. It had the same appearance as coal taken from the Plenty Mine in North Dakota, above Bismarck, and which the *Josephine* was unable to burn alone. Three or four parties have united and tried to work these drifts, but for some reason or other it has not paid, so that the coal can not be of an extra quality.

There is very little irrigating. At Chamberlain was found the first artesian well. There are two here, one owned by the city, giving a great volume of water; the second is owned by a township on the hill above, and was intended to irrigate the surrounding country, a system of ditching having been laid out for that purpose, but the well does not run abundantly and only one farmer gets any water. If the water ran well the scheme ought to be something of a success. Both of these wells are down about 1,000 feet.

Below Chamberlain, artesian wells are more frequent, the artesian basin extending down as far as the James River, at least, where wells are very numerous. Water down here is struck at 200 feet, and the entire cost of a well is only about $75. Many farmers have wells simply to water their cattle, and then let it run to waste, which latter fact shows the difference in rain fall between this and the upper country.

At Niobrara and Yankton there are flour mills run by artesian power. At the latter place, on account of the large output, steam has to assist the running of the mill..

Ordinary surface wells are very common the country over; they are down from 20 to 30 and 40 feet.

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### DESCRIPTIONS OF LOCATIONS OF BENCH MARKS, PRIMARY LEVELING, 1892, FROM CANNONBALL, N. DAK., TO CHAMBERLAIN, S. DAK.

The bench mark generally used and, unless otherwise noted, is a stone 18 by 18 by 4 inches, buried flatwise from 3 to 3½ feet below the surface of the ground, surmounted by a 5-inch gas pipe 4 to 4½ feet long to the top of its cap.

A hole one-half inch in diameter at the middle of the top and dressed surface of the stone marks the level point on that surface; around the hole the letters U. S. B. M. are cut in the stone.

$\frac{198}{1}$ On right bank, about one-half mile below Cannonball River and same distance from Missouri River. In cultivated field just inside of fence along foot of bluffs. Wagon road in cultivated field 100 feet above. Plotted on chart 122.

$\frac{198}{2}$ On left bank, one-half mile from river, on bench 30 feet from edge, and about 1¼ miles below Peter Shire's ranch. Directly back of B. M. is high bluff with bowlders near top. Plotted on chart 122.

$\frac{199}{1}$ On right bank, about one mile back from river, on upper one of two spurs running out from bluffs and about 50 feet back from edge of abrupt slope of spur. Upper line of fence around cultivated field on bottom about 200 feet above. Plotted on chart 122.

$\frac{199}{2}$ On left bank, 300 feet from river and 600 feet above red warehouse on river bank. It is about one-fourth mile above Gayton's ranch. Wagon road in coulee just below and old trail just above B. M. Plotted on chart 122.

$\frac{200}{2}$ On left bank, about 3¼ miles below B. M. $\frac{199}{2}$ and about one-fourth mile below where brush touches bluffs and the same distance above lower end of brush. It is on a round-topped knoll about 800 feet back from river. Wagon road at foot of knoll. Plotted on chart 122.

$\frac{201}{2}$ On left bank, about 3 miles below $\frac{200}{2}$ and about 2 miles above Emmonsburg, N. Dak. Is about one-half mile from river at point where timber begins, on a small knoll just below coulee. High bluff back is covered with stones and bowlders. Plotted on chart 123.

$\frac{202}{1}$ On right bank, 600 feet from river, just above fence line running to river and 15 feet from corner of fence along which main road to Standing Rock passes. Plotted on chart 123.

$\frac{202}{2}$ On left bank, about 1,500 feet from river, one-half mile below Emmonsburg, and about 800 feet above Big Beaver Creek. Is 100 feet back from abrupt slope to bottom and same distance west of old trail. Six hundred feet east of it is stage road. Plotted on chart 123.

${}^{2}\underset{2}{9}{}^{3}$ On left bank, about 3 miles below ${}^{2}\underset{2}{9}{}^{2}$ and about 60 feet from cut bluffs. Just below coulee and below end of timber, brush, and willows, 100 feet from stage road where it goes round point on side hill. Plotted on chart 123.

${}^{2}\underset{3}{9}{}^{3}$ On left bank, 800 feet from river on a flat spur which runs out into a mound-shaped knoll. Stage road runs over hill 100 feet west of B. M. Plotted on chart 123.

${}^{2}\underset{2}{9}{}^{4}$ On left bank, on ridge running through bottom. It is about half-way between river and bluffs and just opposite upper side of Battle Creek Valley. Plotted on chart 124.

${}^{2}\underset{3}{9}{}^{4}$ On left bank, opposite valley of Battle Creek, on small knoll about one-half mile from river. Heavy timber is about one-half mile above and same distance below. Old wagon road along foot of knoll and turns up out of bottom about 500 feet below. Plotted on chart 124.

${}^{2}\underset{1}{9}{}^{5}$ On right bank, at Fort Yates, N. Dak., at northeast corner of parade grounds, 4 feet inside of fence and 6 feet south of double gate. Plotted on chart 124.

${}^{2}\underset{2}{9}{}^{5}$ On left bank, at Winona, N. Dak., about 800 feet from river on high plateau, 300 feet west of houses on street running north and south, and just above road leading to river. Plotted on chart 124.

${}^{2}\underset{2}{9}{}^{6}$ On left bank, about 5 miles below Winona and 800 feet from river, where brush and willows end and river strikes clear bank. Stage road back about 600 feet. It is on the downstream side of little ridge on second bench just where the slope begins. Plotted on chart 125.

${}^{2}\underset{2}{9}{}^{7}$ On left bank, about 4 miles below ${}^{2}\underset{2}{9}{}^{6}$ and 1 mile from river. Road along foot of bluffs. A schoolhouse on plateau below and distant 980 feet. Plotted on chart 126.

${}^{2}\underset{3}{9}{}^{7}$ On left bank, about 1 mile back of ${}^{2}\underset{2}{9}{}^{7}$. Just back is a round-topped knoll, and 1,200 feet south is a shack near creek. Northeast corner of fence is about 800 feet south. Plotted on chart 126.

${}^{2}\underset{2}{9}{}^{8}$ On left bank, about 600 feet from river at point where bottom begins, directly back of Andrew Marsh's store, Vanderbilt, S. Dak. Plotted on chart 127.

${}^{2}\underset{3}{9}{}^{8}$ On left bank, about one-half mile back of ${}^{2}\underset{2}{9}{}^{8}$ just inside of fence at northwest corner of cultivated field. Plotted on chart 127.

${}^{2}\underset{2}{9}{}^{9}$ On left bank, about one-half mile from river and one-fourth mile from La Grace, S. Dak. It is between La Grace and the river on low bench land about 100 feet from edge of bottom and 150 feet below where road turns out of bottom towards La Grace. Plotted on chart 128.

${}^{2}\underset{3}{9}{}^{9}$ On left bank, about 1¼ miles from river and directly back of La Grace on first spur projecting into Spring Creek Valley. Wagon road at foot of knoll. Plotted on chart 128.

${}^{2}\underset{2}{1}{}^{0}$ On left bank, about 4 miles below ${}^{2}\underset{2}{9}{}^{9}$ and one-fourth mile from river on small spur from foot of first bench. Wagon road 30 feet distant towards hill. Stage road about 700 feet towards river. Plotted on chart 128.

${}^{2}\underset{2}{1}{}^{1}$ On left bank, about 7 miles below La Grace and 300 feet from river, just below mouth of creek, on first bench about 75 feet from edge of slope to bottom. Near ranch known as Twiggs Place. Plotted on chart 128.

${}^{2}\underset{3}{1}{}^{1}$ On left bank, about one-third mile back from ${}^{2}\underset{2}{1}{}^{1}$. On lower side of creek valley about 25 feet from edge of abrupt slope to creek. Directly across valley is a sharp-pointed knoll covered with bowlders. Old cattle trail is 25 feet further up the hill. Plotted on chart 128.

${}^{2}\underset{2}{1}{}^{2}$ On left bank, about 5¼ miles below ${}^{2}\underset{2}{1}{}^{1}$ and 200 feet from river. Narrow strips of bottom between river and B. M. about 225 feet southwest of Anon Olson's house. Plotted on chart 129.

${}^{2}\underset{3}{1}{}^{2}$ On left bank, about one-quarter mile back of ${}^{2}\underset{2}{1}{}^{2}$ and about 200 feet south of Olson Creek and 200 feet west of where road crosses creek. Wagon road runs around foot of hill north of B. M. Plotted on chart 129.

${}^{2}\underset{2}{1}{}^{3}$ On right bank, about 3 miles below ${}^{2}\underset{3}{1}{}^{2}$ and 200 feet from river, at head of bottom. It is on a small knoll just below coulee, on east side depression, 15 feet from edge of abrupt slope to bottom. Plotted on chart 130.

${}^{2}\underset{3}{1}{}^{3}$ On left bank, about four miles below ${}^{2}\underset{2}{1}{}^{2}$ and 400 feet from river, and one-half mile below where river leaves cut bluffs and timber begins, 150 feet upstream from red warehouse. Plotted on chart 130.

${}^{2}\underset{2}{1}{}^{4}$ On left bank, opposite a point about 1,000 feet below head of Ashley Island, just back from where first bench strikes river. Small coulee 1,000 feet below. Plotted on chart 131.

${}^{2}\underset{3}{1}{}^{4}$ On left bank, about one half mile east of ${}^{2}\underset{2}{1}{}^{4}$ on second bench, about 60 feet from slope to first bench. Four feet south of east and west line of fence. Plotted on chart 131.

${}^{2}\underset{2}{1}{}^{5}$ On right bank, about 700 feet from river and one-half mile below Grand River, on spur from high knoll running out northwest from B. M. A large granite bowlder buried in hillside about 80 feet northwest of B. M. Plotted on chart 131.

$\frac{215}{2}$ On left bank, one-fourth mile below mouth of Grand River, on a slope of foothills, at head of bottom, in cultivated field. About 50 feet south of deserted shack and 2 feet east of west side of same produced. Plotted on chart 131.

$\frac{216}{1}$ On right bank, on gentle slope, lower side of small creek valley. About 125 feet west of stable and nearly in line with south side of same, 250 feet north of shack. Plotted on chart 132.

$\frac{216}{2}$ On left bank, about 3 miles below $\frac{215}{2}$ and one-fourth mile from river, on first bench. It is about 60 feet south and 50 feet west of Paul Carlson's house. Plotted on chart 132.

$\frac{217}{2}$ On left bank, about 1 mile below foot of Blue Blanket Island. About 800 feet below coulee and 500 feet back from edge of high bluff bank, on level plateau. Plotted on chart 133.

$\frac{217}{3}$ On left bank, about one-half mile from river on spur between two draws at head of small coulee. One log and one sod shack about 1,500 feet south. Plotted on chart 133.

$\frac{218}{2}$ On left bank, about 4¼ miles below $\frac{217}{2}$ and one-fourth mile from river, just at end of small brush along river bank, on first bench about 60 feet from edge of abrupt slope to bottom and just below coulee in which there is a wagon road. Plotted on chart 134.

$\frac{218}{3}$ On left bank about one-half mile back of $\frac{218}{2}$ on flat-topped spur from high bluffs back. Head of coulee just back of B. M., one on each side, joining in front. Wagon road in coulee. Plotted on chart 134.

$\frac{219}{2}$ On left bank, at Le Beau, S. Dak., on spur at end of high plateau just north of Swan Lake Creek Valley, 600 feet east of timber in Missouri River Valley, and 50 feet from slope into creek valley. Plotted on chart 135.

$\frac{219}{3}$ On left bank, at Le Beau, 90 feet west of post-office building, in valley of Swan Lake Creek, about one-half mile back from $\frac{219}{2}$. Plotted on chart 135.

$\frac{220}{2}$ On left bank, at Scranton, S. Dak., about one-half mile from river, 100 feet south of bridge across coulee and 40 feet from wagon road, 280 feet south of corner of store and post-office. Plotted on chart 135.

$\frac{221}{2}$ On left bank, about 2¼ miles below Scranton and 200 feet from river, at end of willow bar, just above mouth of creek. Plotted on chart 136.

$\frac{221}{3}$ On left bank, about one-half mile back from river at mouth of small creek, on flat spur from high bluffs on upper side of valley. Plotted on chart 136.

$\frac{222}{2}$ On left bank, about 4 miles below $\frac{221}{2}$ and just above mouth of creek at head of narrow bottom, about 200 feet from river. Plotted on chart 136.

$\frac{222}{3}$ On left bank, about one-third mile back of $\frac{222}{2}$. About 400 feet above creek and 100 feet above old trail up creek valley. Plotted on chart 136.

$\frac{223}{2}$ On left bank, about 5 miles below $\frac{222}{2}$ and opposite large valley on right bank. About one-fourth mile from river and 50 feet back from edge of high cut bluff. About 100 feet above high butte, standing alone 100 feet from edge of cut bluff. Plotted on chart 137.

$\frac{223}{3}$ On left bank, about one-half mile back from river, on gentle slope of bluffs, just above coulee, which runs back into high bluffs. Red frame house about one-half mile south. Plotted on chart 137.

$\frac{224}{2}$ On left bank, about 2 miles above Old Forest City, S. Dak. About one-half mile from river, on low bench land about 500 feet from edge of slope to bottom and same distance to the foot of bluffs. White frame house in bottom about a mile above and log shack about 1,500 feet below B. M. Plotted on chart 138.

$\frac{225}{2}$ On left bank, at Old Forest City, 550 feet east and 300 feet south of corner of school house and about 300 feet from foot of bluffs. Plotted on chart 138.

$\frac{226}{1}$ On right bank, at Cheyenne River Indian Agency, opposite Forest City, S. Dak., on bench land 30 feet from slope into bottom. It is about 50 feet from the fence at the fifth post from the northeast corner. Plotted on chart 138.

$\frac{226}{2}$ On left bank at Forest City, 20 feet from river bank, 60 feet above mouth of coulee and about 140 feet below Hotel Hathaway. Plotted on chart 138.

$\frac{227}{2}$ On left bank, about 4¼ miles below Forest City and 600 feet from river bank, on high prairie bench which slopes gradually just below. At lower end of where there is open prairie to river for one-quarter mile. Plotted on chart 139.

$\frac{227}{3}$ On left bank, about one-third mile back of $\frac{227}{2}$, on gentle slope at foot of bluffs, about 700 feet below coulee, with log shack in mouth. About 500 feet above spur running out from bluffs into flat. Plotted on chart 139.

$\frac{228}{2}$ On left bank, about 3 miles below $\frac{227}{2}$ and 500 feet from river bank in bottom. Wagon road to river about 50 feet above. About one-half mile above mouth of Pascal Creek, on right bank. Plotted on chart 140.

$\frac{228}{3}$ On left bank, about one-half mile back of $\frac{228}{2}$ and one-quarter mile below house of C. B. Rosa, just outside of fence line on gentle slope at foot of bluffs. Plotted on chart 140.

$\frac{229}{2}$ On the left bank, about 5¼ miles below $\frac{228}{2}$, and 400 feet from river, on mound in bottom. Scattering brush in bottom, but clear in the vicinity of B. M. Wagon road 25 feet above leads to river, about 2 miles below where river strikes bluffs. Plotted on chart 141.

${}^{2}{}_{3}^{9}$ On left bank, about three-fourths mile back of ${}^{2}{}_{3}^{8}$, 300 feet back from edge of first bench and 400 feet from foot of bluffs, and one-third mile above house of S. C. Leppelmann 200 feet above cultivated field. Plotted on chart 141.

${}^{2}{}_{3}^{10}$ On left bank, about 4¼ miles below ${}^{2}{}_{3}^{8}$, and 250 feet from river on rolling prairie, one-fourth mile below where high bluffs leave river. A short broad coulee is just back of B. M. Wagon road about 125 feet back. Plotted on chart 141.

${}^{2}{}_{3}^{1}$ On left bank, at Fairbank, S. Dak., 700 feet from river on first bench land, 30 feet from the edge of slope into the bottom, small coulee just above. Is just opposite lower end of Plum Island. Plotted on chart 142.

${}^{2}{}_{3}^{1}$ On left bank, at Fairbank, S. Dak., about one-fourth mile back of store and hotel and on top of flat mound about 30 feet back from edge of abrupt slope. About three-fourths mile from river, opposite foot of Plum Island. Plotted on chart 142.

${}^{2}{}_{3}^{2}$ On right bank, about one-third mile from river and on first bench land, about 110 feet from the edge of slope. Opposite a point a little below foot of Devil's Island. Is located in a draw which develops into a coulee at edge of bench. Plotted on chart 142.

${}^{2}{}_{3}^{2}$. On left bank, just a little below willows at foot of Devil's Island, on slope of hill between two coulees, 150 feet from the edge of cut river bank. Plotted on chart 143.

${}^{2}{}_{3}^{3}$ On left bank, about 3 miles below ${}^{2}{}_{3}^{2}$, and about 300 feet from river bank on slope of grassy hill just below large coulee which has three branches. This hill is the only one in the vicinity, one-third mile above the lower end of "bad lands" along river. Plotted on chart 143.

${}^{2}{}_{3}^{4}$ On left bank, about three and one-fourth miles below ${}^{2}{}_{3}^{3}$, and 600 feet from river on knoll in the bottom, about one-fourth mile above point of timber. Plotted on chart 144.

${}^{2}{}_{3}^{4}$ On left bank, about three and one-fourth miles below ${}^{2}{}_{3}^{4}$, and three-fourths mile from river, on a flat knoll on slope of foot hills, just above where heavy timber begins, 100 feet west of north and south line of wire fence, along which is a wagon road. Is about one-fourth mile to foot of bluffs. Plotted on chart 144.

${}^{2}{}_{3}^{5}$ On left bank, about 4 miles below ${}^{2}{}_{3}^{4}$, one-fourth mile from river, on a ridge in clear ground back of timber. Another strip of timber and brush back about 40 feet where trail comes out of brush. About 20 feet from gate at entrance of an inclosed field. Plotted on chart 145.

${}^{2}{}_{3}^{5}$ On left bank, about 4 miles below ${}^{2}{}_{3}^{4}$ and three-fourths mile from river, on first bench. Brush along foot of bluffs back of B. M., but clear in front. Log shack in bottom about 100 feet above and the same distance towards the river. Plotted on chart 145.

${}^{2}{}_{3}^{6}$ On left bank, about 5 miles below ${}^{2}{}_{3}^{5}$, opposite point a little above Old Fort Bennett, about 200 feet from river and just above coulee. Old shack covered with barrel staves 1,000 feet back. Plotted on chart 146.

${}^{2}{}_{3}^{6}$ On left bank, about one-fourth of a mile back of ${}^{2}{}_{3}^{6}$, on slope at foot of bluffs, at head of coulee, 320 feet back of log shack covered with barrel staves. Plotted on chart 146.

${}^{2}{}_{3}^{7}$ On left bank, about 3 miles below ${}^{2}{}_{3}^{6}$, about three-fourths of a mile from river, on spur at foot of bluffs just above coulee. Wagon road 50 feet from foot of bluffs. Opposite a point about one mile from head of Whiskey Island. Plotted on chart 146.

Fort Sully, S. Dak. On north corner of south brick window sill on east side of water-works pump house, is a mark cut into the brick and marked U. S. B. M.

${}^{2}{}_{3}^{8}$ On left bank, just below first coulee below Fort Sully, on high bench 60 feet from edge of slope to creek, and 80 feet from edge of slope to river bottom. Plotted on chart 147.

${}^{2}{}_{3}^{8}$ On left bank, about one-fourth of a mile back of ${}^{2}{}_{3}^{8}$, in coulee just below Fort Sully, on little spur over which a wagon road passes, 20 feet south. Plotted on chart 147.

${}^{2}{}_{3}^{9}$ On left bank, about 3 miles below ${}^{2}{}_{3}^{8}$, and 400 feet from river. Fifteen feet south of old wagon road, 225 feet north of another road, and 550 feet below where roads join. Is about one-fourth mile above the "Lower Sully Landing." Plotted on chart 147.

${}^{2}{}_{3}^{2}$ On left bank, about 3 miles below Fort Sully, S. Dak., about three-fourths mile from river. It is on a very gentle slope from bench land to river, 400 feet back from main wagon road and 200 feet towards river from foot of abrupt slope up to first bench. It is just below a coulee. Plotted on chart 147.

${}^{2}{}_{4}^{0}$ On left bank, about 3¼ miles below ${}^{2}{}_{3}^{2}$ and 1 mile from river, on first bench near edge of slope 450 feet above Spring Creek. Plotted on chart 148.

${}^{2}{}_{4}^{1}$ On left bank, about 3¼ miles below ${}^{2}{}_{4}^{0}$, and 150 feet from river, on high plateau, 75 feet from the edge of slope and just below deep narrow ravine. Plotted on chart 148.

$\frac{241}{3}$ On left bank, about 800 feet back of $\frac{241}{2}$, on gentle slope. Deep coulee above about 150 feet. Rolling plateau below. Plotted on chart 148.

$\frac{242}{2}$ On left bank about 2¼ miles below $\frac{241}{2}$, and 300 or 400 feet below where clear prairie bottom begins, on high plateau about 100 feet back from the edge of abrupt slope to bottom. Plateau is rolling above, but nearly level below. Plotted on chart 148.

$\frac{243}{2}$ On left bank, about 2¼ miles below $\frac{242}{2}$, and just below end of timber, one-fourth mile from river, about 1,000 feet southeast of Oahe Mission on low bench, about 75 feet from edge of slope. Plotted on chart 149.

$\frac{243}{3}$ On left bank, about 2¼ miles below $\frac{242}{2}$, and 1 mile back of $\frac{243}{2}$, and 150 feet from foot of abrupt slope, three-fourths mile back of Oahe Mission. Just above coulee in which is an old trail 15 feet north of B. M. Graveyard on top of hill about 700 feet above. Plotted on chart 149.

$\frac{244}{2}$ On left bank, about 4 miles below $\frac{243}{2}$, on edge of first bench just back of timber and brush. One-fourth mile from foot of bluffs, one-third mile below white schoolhouse at foot of bluffs, 100 feet upstream from bench line. Plotted on chart 150.

$\frac{245}{2}$ On left bank, about 2¼ miles below $\frac{244}{2}$, 200 feet from river. Bluffs strike river about three-fourths mile below. Is about three-fourths mile southwest of Secondary triangulation station Stony Hill, and opposite a point 1,000 feet below head of willows on an island. Plotted on chart 150.

$\frac{245}{3}$ On left bank, about 2¼ miles below $\frac{244}{2}$, and one-half mile from river, on first bench, 250 feet from the edge of slope. Wagon road at foot of bench. It is opposite a point about one-fourth mile below the head of the island. Secondary triangulation station Stony Hill is about one-third mile east. Plotted on chart 150.

$\frac{246}{2}$ On left bank, about 2¼ miles below $\frac{245}{2}$, and a little above the lower end of willows on small island. Is about 60 feet back from the edge of abrupt slope, on second high grassy knoll above high cut gumbo hill. Plotted on chart 150.

$\frac{247}{2}$ On left bank, about 2¼ miles below $\frac{246}{2}$, just above mouth of small creek and 30 feet back from abrupt slope to river, 50 feet north of small shack in side of hill near river bank. Is a little above the town of Stanley, which is on opposite bank. Plotted on chart 151.

$\frac{248}{1}$ On right bank, at Fort Pierre, S. Dak., about 700 feet back from river and the same distance above Bad River, on a gumbo hill just back of houses on Deadwood street. Plotted on chart 152.

$\frac{248}{2}$ On left bank, at Pierre, S. Dak., in court-house yard, on west side. Plotted chart 152.

Pierre, S. Dak. At corner of Pierre street and Sioux avenue. Top of cap on hydrant.

At top of rail, Chicago and North-Western Railway track in front of depot.

Weather Bureau B. M. on the doorstep at the entrance to the National Bank of Commerce building.

$\frac{249}{2}$ On left bank, just inside of fence around the Pierre Indian Training School. It is 100 feet north and 150 feet west of the northwest corner of the main building, 2 feet south of 6th fence post south of gate at entrance to grounds. Plotted on chart 152.

$\frac{250}{2}$ On left bank, about 3¼ miles below B. M. $\frac{249}{2}$ on small gumbo knoll opposite about the middle of Farm Island, 150 feet from river bank and 225 feet from Chicago and North-Western Railway, at a point 90 feet below bridge No. 283. Plotted on chart 152.

$\frac{250}{3}$ On left bank, about one-fourth mile back of $\frac{250}{2}$ in coulee. House on top of hill directly back about one-half mile. Secondary triangulation station Barth is on a high knoll just below. Plotted on chart 152.

$\frac{251}{2}$ On left bank, about 2¾ miles below $\frac{250}{2}$ and 1,000 feet from river bank. It is on low bench land, just above fence line which runs to river bank and above a grove of small cottonwood trees. Plotted on chart 152.

$\frac{252}{2}$ On left bank, about 2¾ miles below $\frac{251}{2}$ 200 feet from river, where prairie bottom slopes up and gets higher along the river. It is just above the line of fence which runs to the river bank. Shack one-fourth mile above and another one-fourth mile below. Plotted on chart 153.

$\frac{252}{3}$ On left bank, in flat gumbo bottom about 240 feet back from Chicago and Northwestern Railway track at a point 40 feet above milepost No. 271, and 270 feet above road crossing. Plotted on chart 153.

$\frac{253}{2}$ On left bank, at Rousseau, S. Dak., straight out from $\frac{253}{3}$ one-fourth mile. It is just back of brush along river bank. A small patch of cultivated land is 15 feet west. Plotted on chart 153.

$\frac{253}{3}$ On left bank, at Rousseau, S. Dak., on side hill just on corner of bluffs bounding the Creek valley and the Missouri River valley. About 1,000 feet above the section house. A black cross is in graveyard about 1,000 feet northwest. Railroad is 100 feet from the foot of hill. Plotted on chart 153.

$\frac{254}{3}$ On left bank, about 3 miles below Rousseau and three-fourths mile from river.

It is on a gentle slope of bluffs, about 150 feet back from slope to timbered bottom. Plotted on chart 154.

$\frac{253}{3}$ On left bank, about 3 miles below $\frac{252}{2}$ and about 80 feet from the edge of a cut bank, just where there is an old trail leading to the water. It is on a spur between two small draws, and is about 400 feet below the mouth of a creek where there are several large trees. Plotted on chart 154.

$\frac{254}{3}$ On left bank, about 3 miles below $\frac{253}{2}$ and 700 feet from river. It is on the top of a high rolling plateau, 180 feet below the slope into a wide coulee, in which are large trees near the mouth, also two shacks, one above and one below the creek bed. Plotted on chart 154.

$\frac{255}{3}$ On left bank, about 3 miles below $\frac{254}{2}$ and 600 feet from river bank. It is about one-half mile above Chapelle Creek, and about 20 feet from edge of slope into low bottom covered with willows and brush. It is about 340 feet below the corner of fence. Plotted on chart 154.

$\frac{256}{3}$ On left bank, 3 miles below $\frac{255}{2}$ and about one-third mile back from $\frac{256}{2}$. It is on bench land about 200 feet from edge of slope and 900 feet below small shack. Plotted on chart 154.

$\frac{257}{3}$ On left bank, about 3 miles below Chapelle Creek. It is opposite the end of willows of shore bar, on the slope of hills, 75 feet from the edge of an abrupt slope to river, coulee just below. Plotted on chart 155.

$\frac{258}{2}$ On left bank, about 3 miles below $\frac{257}{2}$, one-quarter mile below head of bottom and one-half mile above head of Dorion Island No. 2. It is on the edge of first bench land, 20 feet from the edge of abrupt slope. Plotted on chart 155.

$\frac{258}{3}$ On left bank, on top of plateau, 530 feet east and 470 feet south of B. M. $\frac{258}{2}$. Plotted on chart 155.

$\frac{259}{2}$ On left bank, 3¼ miles below $\frac{258}{2}$, and about one-half mile below the head of Dorion Island No. 1. It is on a high plateau, about 350 feet from the river and 150 feet from the edge of the slope of the plateau. It is in the northeast corner of NE. ¼ of sec. 13, R. 75, T. 108. The azimuth from the B. M. to the section corner is 176° 11′, and the distance 382 feet. Plotted on chart 155.

$\frac{260}{2}$ On left bank, about 3 miles below $\frac{259}{2}$, on sand ridge which forms a well defined bench, meeting river bank about 500 feet below. A few scattering trees and brush are on lower bottom. Plotted on chart 156.

$\frac{260}{3}$ On left bank, about 3 miles below $\frac{259}{3}$ and one-half mile from river. It is on the slope from the bottom to high bench land, and about 360 feet below coulee. Plotted on chart 156.

$\frac{261}{2}$ On left bank, about 3 miles below $\frac{260}{2}$, and about 700 feet from river. Timber commences about 1,000 feet below along river bank. Ruins of old shack on edge of low brush land about 600 feet back. There is also a shack one-half mile below. Plotted on chart 156.

$\frac{262}{2}$ On the left bank, about 3¼ miles below $\frac{261}{2}$ and 300 feet from river. It is below the end of timber, on a low bench, 20 feet from the edge of slope to narrow point of bottom. Plotted on chart 157.

$\frac{262}{3}$ On the left bank, 3¼ miles below $\frac{261}{2}$ and 1,000 feet from river. It is on the slope of the hills just back from the end of timber. Brush about 300 feet below along coulee, and large trees at foot of high hills about 700 feet back. Plotted on chart 157.

$\frac{263}{2}$ On left bank, about 3¼ miles below $\frac{262}{2}$, on slope of hill between two small coulees. It is just above where the rough country begins near river bank, and about 70 feet back from where slope is abrupt to cut bank of river. Plotted on chart 157.

$\frac{264}{2}$ On left bank, about 3¼ miles below $\frac{263}{2}$ and 400 feet from river. It is on the slope of a hill about 1,000 feet below where timber begins along river, and just above the third small coulee below the timber. Plotted on chart 158.

$\frac{264}{3}$ On left bank, about 3¼ miles below $\frac{263}{2}$, 600 feet back of B. M. $\frac{264}{2}$, on gentle slope toward small coulee, which heads just back and below B. M. Plotted on chart 158.

$\frac{265}{2}$ On left bank, about 3 miles below $\frac{264}{2}$, is on a sand hill about 400 feet back of timber line. A bunch of choke cherry brushes is about 25 feet back, and a well-defined bench about 12 feet high, is about 600 feet back. Plotted on chart 158.

$\frac{266}{1}$ On right bank, on the neck of the Big Bend. It is opposite a point on the left bank about 1,000 feet above the lower end of timber, and is on spur from the foot of hills; 40 feet back is abrupt slope up. Brush is scattered along the side hills below. Plotted on chart 158.

$\frac{266}{2}$ On left bank, about 1¾ miles below $\frac{265}{2}$. It is on the edge of the first bench land, back of the timber and one-fourth mile above the end of it. Plotted on chart 158.

$\frac{267}{1}$ On right bank, about 3¼ miles below $\frac{266}{1}$ and 100 feet from river. It is on a small broken ridge running parallel with the river, opposite the center of timber on Devil's Island, and just at the upper end of a row of large trees. Plotted on chart 159.

$\frac{268}{1}$ On right bank, on a spur of broken rolling bench land, where it turns and the bottom land begins. It is on the point of Big Bend, just at the end of a narrow belt of large timber along river bank opposite foot of St. John Island. Plotted on chart 159.

$^{269}$ On right bank, about 800 feet back of B. M. $^{269}$ on flat bottom land. Plotted on chart 159.

$^{269}$ On right bank, about 3 miles below $^{268}$ and about one-third of a mile from the river. It is on a sand hill just back of timber, and one-fourth mile above an old shack. Plotted on chart 159.

$^{270}$ On right bank, about 3 miles below $^{269}$, on a long sand ridge, just at the lower end of timber along river. A low bottom is back of it, with scattering small brush and few large trees. Plotted on chart 160.

$^{271}$ On right bank, about 4 miles below $^{270}$, on low bench land about 700 feet from river and opposite lower end of timber on left bank. It is about 500 feet from where higher bench starts out. A single large cottonwood tree is 100 feet below and 3 or 4 small ones are 50 feet above. Plotted on chart 160.

$^{272}$ On right bank, about 4 miles below $^{271}$ on bench land about 50 feet from edge and 150 feet above small coulee, with two large trees near mouth and small trees for 500 feet back. An old shack is about 150 feet above, and another above 500 feet back. The gate of the Government fence is back of the brush line a little above the B. M. Plotted on chart 161.

$^{273}$ On right bank, about one third of a mile back of $^{273}$. It is 70 feet north and 25 feet east from the northeast corner of William Smith's shack. "Good Road's" shack is across the creek and nearly north of the B. M. Plotted on chart 161.

$^{273}$ On right bank about 3 miles below $^{272}$, about 500 feet from river bank. It is just below a creek and about one mile from where the high bluffs commence to strike the river. It is about 150 feet west from a small knoll. Two shacks are about one-third of a mile back where William Smith lives, and "Good Road's" lives just above the B. M. by the creek. Plotted on chart 161.

$^{274}$ On right bank, about 3 miles below $^{273}$, and about 20 feet back from the edge of a cut bluff bank. A deep coulee is above it, with a high rock bank on the upper side, and a low bank on the other side. A small deep coulee is also below the B. M. The sides of the bluffs back and a little below are covered with cedar trees. Plotted on chart 162.

$^{275}$ On right bank, about 2 miles below $^{274}$, and opposite Crow Creek Indian Agency. It is on a small ridge, on the upper side of a small creek valley. Brush and trees are along the creek, and a patch of brush is just above the B. M. Plotted on chart 162.

$^{276}$ On right bank, about 3 miles below $^{275}$, on a spur of broken plateau just above small creek. It is 300 feet from the river and a little below the lower end of heavy timber on left bank. Plotted on chart 162.

$^{277}$ On right bank, about 3½ miles below $^{276}$, at site of Old Fort Hale. It is on low foot hills about 150 feet below an old excavation, and is directly back from a grove of large trees in the bottom. Brush is along the foot of the bluffs, and in coulee just below. Plotted on chart 163.

$^{278}$ On right bank, about 3 miles below $^{277}$, on top of a high broken plateau. It is about 200 feet below a coulee up which runs a wagon road from the bottom. Frame house in bottom directly in front of it, and Indian shack on the plateau about 300 feet north and west. It is about 100 feet from the corner of a fence. Plotted on chart 164.

$^{279}$ On right bank, about 3½ miles below $^{278}$, about 400 feet above where river strikes the bluffs and just above first coulee back from where river strikes bluffs. It is on a spur from the high bluffs about 20 foot from the edge of the cut bluff bank. Plotted on chart 164.

$^{280}$ On right bank, about 3½ miles below $^{279}$, on spur of hills just below a coulee, a small shack is 200 feet above, and a frame house about 700 feet below. Plotted on chart 164.

$^{281}$ On right bank, about 1½ miles below $^{280}$, on low bench land back from the end of timber along the river. Four large trees are in the prairie below and a strip of brush is along the foot of bench. A small two-story house is on the second bench a little below B. M. Plotted on chart 165.

Chamberlain, S. Dak.: Chicago, Milwaukee and St. Paul Railway depot. Top of rail nearest the depot, of the main track in front of the signal board.

Chicago, Milwaukee and St. Paul Railway water tank. Top of rail nearest tank in front of water spout.

City B. M.: An iron monument at the center of the intersection of Main and Clemens streets. The monument is 2.5 feet long, of cast iron, and is set about 1 foot below the surface of the street.

B. M.: On brick water table at the northeast corner of the Taft House.

B. M.: On water table of High School, close up to the brick work of the northwest corner of the building. It is about 4 inches above ground. The beveled edge of the water table on the north side is painted white and marked "1,468.22 feet above sea level."

[illegible] At Chamberlain, S. Dak., in the High School yard. It is 90 feet west and 18 feet north from the southwest corner south wing of this building. Plotted on chart 165.

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*Elevations and geographical positions of bench marks, primary leveling, 1892, Cannonball, N. Dak., to Chamberlain, S. Dak.*

[The datum plane is approximately 71.2 feet below mean Gulf tide at Biloxi, Miss.]

| Bench mark. | Elevation. | Latitude. | | | Longitude. | | |
|---|---|---|---|---|---|---|---|
| | | ° | ′ | ″ | ° | ′ | ″ |
| [illegible] | 1,707.016 | 46 | 27 | 21.55 | 100 | 34 | 54.04 |
| [illegible] | 1,681.686 | 46 | 24 | 50.27 | 100 | 35 | 39.36 |
| [illegible] | 1,703.465 | 46 | 25 | 06.00 | 100 | 33 | 41.62 |
| [illegible] | 1,734.469 | 46 | 22 | 25.90 | 100 | 34 | 33.62 |
| [illegible] | 1,702.459 | 46 | 22 | 42.34 | 100 | 33 | 15.47 |
| [illegible] | 1,708.377 | 46 | 18 | 46.62 | 100 | 32 | 21.44 |
| [illegible] | 1,699.102 | 46 | 16 | 42.12 | 100 | 34 | 06.79 |
| [illegible] | 1,692.388 | 46 | 14 | 30.83 | 100 | 33 | 48.85 |
| [illegible] | 1,691.168 | 46 | 14 | 35.48 | 100 | 32 | 30.64 |
| [illegible] | 1,680.155 | 46 | 12 | 11.98 | 100 | 34 | 37.97 |
| [illegible] | 1,713.241 | 46 | 12 | 10.92 | 100 | 34 | 27.75 |
| [illegible] | 1,666.508 | 46 | 09 | 10.19 | 100 | 36 | 42.56 |
| [illegible] | 1,684.504 | 46 | 09 | 05.05 | 100 | 36 | 23.62 |
| [illegible] | 1,710.250 | 46 | 05 | 27.28 | 100 | 37 | 34.95 |
| [illegible] | 1,694.168 | 46 | 06 | 04.38 | 100 | 36 | 10.16 |
| [illegible] | 1,674.535 | 46 | 01 | 08.81 | 100 | 33 | 07.12 |
| [illegible] | 1,712.370 | 45 | 58 | 08.47 | 100 | 29 | 38.20 |
| [illegible] | 1,768.797 | 45 | 58 | 44.40 | 100 | 28 | 57.46 |
| [illegible] | 1,704.510 | 45 | 55 | 29.33 | 100 | 25 | 52.11 |
| [illegible] | 1,726.535 | 45 | 55 | 45.33 | 100 | 25 | 19.31 |
| [illegible] | 1,648.443 | 45 | 52 | 29.36 | 100 | 21 | 30.34 |
| [illegible] | 1,712.344 | 45 | 53 | 01.63 | 100 | 21 | 18.08 |
| [illegible] | 1,639.105 | 45 | 48 | 59.32 | 100 | 21 | 38.73 |
| [illegible] | 1,659.108 | 45 | 46 | 57.17 | 100 | 20 | 52.00 |
| [illegible] | 1,686.031 | 45 | 47 | 07.93 | 100 | 20 | 39.54 |
| [illegible] | 1,665.483 | 45 | 42 | 55.18 | 100 | 17 | 53.48 |
| [illegible] | 1,678.656 | 45 | 43 | 01.65 | 100 | 17 | 37.48 |
| [illegible] | 1,657.007 | 45 | 40 | 48.84 | 100 | 18 | 50.92 |
| [illegible] | 1,645.251 | ..... | ..... | ..... | ..... | ..... | ..... |
| [illegible] | 1,636.749 | 45 | 37 | 25.30 | 100 | 25 | 05.96 |
| [illegible] | 1,687.291 | 45 | 37 | 22.29 | 100 | 24 | 23.01 |
| [illegible] | 1,644.683 | 45 | 33 | 50.99 | 100 | 28 | 40.78 |
| [illegible] | 1,640.200 | 45 | 33 | 44.44 | 100 | 27 | 49.02 |
| [illegible] | 1,631.418 | 45 | 30 | 20.20 | 100 | 25 | 58.42 |
| [illegible] | 1,624.523 | 45 | 30 | 51.10 | 100 | 26 | 05.22 |
| [illegible] | 1,677.656 | 45 | 28 | 47.34 | 100 | 20 | 22.80 |
| [illegible] | 1,675.943 | 45 | 28 | 55.78 | 100 | 19 | 58.20 |
| [illegible] | 1,660.432 | 45 | 23 | 25.99 | 100 | 15 | 43.27 |
| [illegible] | 1,719.883 | 45 | 23 | 31.40 | 100 | 15 | 18.93 |
| [illegible] | 1,623.061 | 45 | 17 | 57.12 | 100 | 17 | 57.71 |
| [illegible] | 1,615.362 | 45 | 18 | 23.46 | 100 | 17 | 38.51 |
| [illegible] | 1,619.860 | 45 | 16 | 44.36 | 100 | 16 | 34.61 |
| [illegible] | 1,612.462 | 45 | 13 | 55.53 | 100 | 14 | 55.24 |
| [illegible] | 1,654.858 | 45 | 14 | 02.44 | 100 | 14 | 31.81 |
| [illegible] | 1,630.690 | 45 | 10 | 11.86 | 100 | 16 | 15.82 |
| [illegible] | 1,641.745 | 45 | 10 | 06.84 | 100 | 15 | 50.44 |
| [illegible] | 1,653.454 | 45 | 06 | 22.88 | 100 | 19 | 24.51 |
| [illegible] | 1,700.951 | 45 | 06 | 19.38 | 100 | 17 | 58.64 |
| [illegible] | 1,591.278 | 45 | 03 | 00.60 | 100 | 17 | 26.50 |
| [illegible] | 1,592.906 | 45 | 01 | 32.59 | 100 | 15 | 31.73 |
| [illegible] | 1,599.085 | 45 | 01 | 08.39 | 100 | 18 | 04.10 |
| [illegible] | 1,597.500 | 45 | 00 | 43.67 | 100 | 18 | 05.20 |
| [illegible] | 1,590.293 | 45 | 00 | 20.55 | 100 | 24 | 13.03 |
| [illegible] | 1,617.976 | 45 | 00 | 11.82 | 100 | 23 | 52.59 |
| [illegible] | 1,572.334 | 44 | 58 | 05.04 | 100 | 24 | 54.50 |
| [illegible] | 1,612.368 | 44 | 58 | 04.00 | 100 | 24 | 27.13 |
| [illegible] | 1,570.678 | 44 | 52 | 57.51 | 100 | 23 | 29.26 |
| [illegible] | 1,577.988 | 44 | 53 | 09.61 | 100 | 22 | 57.72 |
| [illegible] | 1,585.973 | 44 | 49 | 50.60 | 100 | 26 | 00.97 |
| [illegible] | 1,574.678 | 44 | 47 | 24.89 | 100 | 29 | 59.33 |
| [illegible] | 1,637.304 | 44 | 47 | 08.54 | 100 | 29 | 24.36 |
| [illegible] | 1,583.834 | 44 | 46 | 02.70 | 100 | 34 | 48.88 |
| [illegible] | 1,594.339 | 44 | 45 | 57.66 | 100 | 35 | 54.78 |
| [illegible] | 1,602.787 | 44 | 48 | 25.50 | 100 | 39 | 41.70 |
| [illegible] | 1,556.141 | 44 | 47 | 50.00 | 100 | 43 | 18.31 |
| [illegible] | 1,603.307 | 44 | 47 | 45.82 | 100 | 42 | 37.63 |
| [illegible] | 1,542.867 | 44 | 44 | 51.33 | 100 | 38 | 36.75 |
| [illegible] | 1,564.787 | 44 | 45 | 08.84 | 100 | 38 | 18.00 |
| [illegible] | 1,561.585 | 44 | 40 | 39.76 | 100 | 36 | 38.16 |
| [illegible] | 1,609.283 | 44 | 40 | 34.72 | 100 | 36 | 20.47 |
| [illegible] | 1,540.964 | 44 | 37 | 56.79 | 100 | 37 | 25.88 |

*Elevations and geopraphical positions of bench marks, etc.*—Continued.

| Bench mark. | Elevation. | Latitude. | | | Longitude. | | |
|---|---|---|---|---|---|---|---|
| | | ° | ′ | ″ | ° | ′ | ″ |
| Fort Sully, S. Dak.—(Window sill of pump house) | 1,532.576 | | | | | | |
| 238 | 1,564.423 | 44 | 34 | 48.73 | 100 | 36 | 38.62 |
| 238 | 1,572.251 | 44 | 34 | 54.10 | 100 | 36 | 23.96 |
| 239 | 1,528.723 | 44 | 33 | 27.47 | 100 | 33 | 32.14 |
| 239 | 1,541.662 | 44 | 33 | 48.37 | 100 | 33 | 36.65 |
| 240 | 1,545.178 | 44 | 32 | 22.54 | 100 | 29 | 50.46 |
| 241 | 1,567.586 | 44 | 30 | 15.96 | 100 | 33 | 09.96 |
| 241 | 1,597.098 | 44 | 30 | 08.35 | 100 | 33 | 06.78 |
| 242 | 1,595.727 | 44 | 28 | 33.49 | 100 | 34 | 22.49 |
| 243 | 1,518.820 | 44 | 27 | 14.18 | 100 | 31 | 17.27 |
| 243 | 1,550.860 | 44 | 28 | 01.45 | 100 | 31 | 40.06 |
| 244 | 1,510.485 | 44 | 28 | 20.80 | 100 | 27 | 20.80 |
| 245 | 1,508.091 | 44 | 27 | 51.48 | 100 | 24 | 46.82 |
| 245 | 1,542.469 | 44 | 28 | 04.65 | 100 | 24 | 36.83 |
| 246 | 1,557.810 | 44 | 25 | 53.99 | 100 | 22 | 41.52 |
| 247 | 1,522.833 | 44 | 23 | 43.96 | 100 | 22 | 16.04 |
| 248 | 1,523.319 | 44 | 21 | 13.76 | 100 | 22 | 16.79 |
| 248 | 1,563.010 | 44 | 22 | 06.45 | 100 | 21 | 02.45 |
| Pierre, S. Dak.—Gauge B. M | 1,504.757 | | | | | | |
| Pierre, S. Dak.—Corner Pierre street and Sioux avenue. | 1,509.627 | | | | | | |
| Pierre, S. Dak.—Chicago and Northwestern Railway depot | 1,506.085 | | | | | | |
| Pierre, S. Dak.—Weather Bureau B. M | 1,513.212 | | | | | | |
| △ West base | 1,500.145 | 44 | 21 | 14.97 | 100 | 19 | 47.76 |
| 249 | 1,515.897 | 44 | 21 | 08.20 | 100 | 18 | 32.88 |
| △ East base | 1,503.431 | 44 | 20 | 46.24 | 100 | 17 | 07.56 |
| 250 | 1,512.826 | 44 | 20 | 26.05 | 100 | 14 | 30.27 |
| 250 | 1,542.147 | 44 | 20 | 34.67 | 100 | 14 | 23.71 |
| 251 | 1,494.677 | 44 | 19 | 47.32 | 100 | 13 | 37.41 |
| 252 | 1,493.698 | 44 | 19 | 24.71 | 100 | 08 | 34.37 |
| 252 | 1,497.461 | 44 | 19 | 37.81 | 100 | 08 | 33.52 |
| 253 | 1,486.900 | 44 | 18 | 48.47 | 100 | 04 | 52.91 |
| 253 | 1,507.059 | 44 | 19 | 10.48 | 100 | 04 | 50.24 |
| 254 | 1,520.301 | 44 | 17 | 43.01 | 100 | 02 | 01.42 |
| 255 | 1,503.817 | 44 | 16 | 21.35 | 99 | 59 | 19.84 |
| 255 | 1,533.768 | 44 | 16 | 27.44 | 99 | 59 | 16.01 |
| 256 | 1,480.710 | 44 | 16 | 09.93 | 99 | 55 | 47.68 |
| 256 | 1,496.690 | 44 | 16 | 26.72 | 99 | 55 | 47.15 |
| 257 | 1,520.632 | 44 | 14 | 19.80 | 99 | 53 | 14.78 |
| 258 | 1,511.482 | 44 | 12 | 37.94 | 99 | 55 | 07.16 |
| 258 | 1,528.880 | 44 | 12 | 33.28 | 99 | 54 | 50.84 |
| 259 | 1,515.751 | 44 | 09 | 48.39 | 99 | 54 | 28.19 |
| 260 | 1,475.302 | 44 | 07 | 45.16 | 99 | 52 | 13.45 |
| 260 | 1,497.797 | 44 | 08 | 07.90 | 99 | 52 | 07.01 |
| 261 | 1,467.646 | 44 | 07 | 50.85 | 99 | 49 | 46.16 |
| 262 | 1,474.902 | 44 | 08 | 14.12 | 99 | 45 | 44.43 |
| 262 | 1,516.406 | 44 | 08 | 21.19 | 99 | 45 | 41.40 |
| 263 | 1,496.382 | 44 | 07 | 12.61 | 99 | 42 | 26.06 |
| 264 | 1,499.221 | 44 | 06 | 13.07 | 99 | 38 | 51.25 |
| 264 | 1,519.631 | 44 | 06 | 18.12 | 99 | 38 | 53.09 |
| 265 | 1,464.193 | 44 | 07 | 16.42 | 99 | 36 | 15.22 |
| 266 | 1,496.120 | 44 | 08 | 47.06 | 99 | 36 | 30.55 |
| 266 | 1,462.698 | 44 | 08 | 30.66 | 99 | 36 | 48.78 |
| 267 | 1,474.771 | 44 | 10 | 13.41 | 99 | 39 | 34.50 |
| 268 | 1,477.837 | 44 | 11 | 49.85 | 99 | 41 | 21.88 |
| 269 | 1,444.846 | 44 | 12 | 35.60 | 99 | 39 | 10.52 |
| 269 | 1,455.475 | 44 | 12 | 44.07 | 99 | 39 | 10.53 |
| 270 | 1,449.835 | 44 | 11 | 57.73 | 99 | 35 | 49.22 |
| 271 | 1,440.868 | 44 | 09 | 24.06 | 99 | 33 | 18.95 |
| 272 | 1,457.396 | 44 | 05 | 58.29 | 99 | 34 | 42.74 |
| 273 | 1,473.650 | 44 | 03 | 58.94 | 99 | 32 | 50.89 |
| 273 | 1,444.478 | 44 | 04 | 16.27 | 99 | 32 | 35.16 |
| 274 | 1,452.887 | 44 | 02 | 54.74 | 99 | 29 | 21.90 |
| 274 | 1,447.158 | 44 | 02 | 22.75 | 99 | 26 | 55.34 |
| 276 | 1,465.235 | 44 | 01 | 03.64 | 99 | 23 | 36.83 |
| 277 | 1,438.140 | 43 | 58 | 43.38 | 99 | 21 | 32.76 |
| 278 | 1,467.414 | 43 | 56 | 32.89 | 99 | 22 | 02.49 |
| 279 | 1,446.575 | 43 | 53 | 56.27 | 99 | 22 | 02.86 |
| 280 | 1,433.380 | 43 | 52 | 08.89 | 99 | 19 | 08.22 |
| 281 | 1,418.045 | 43 | 50 | 47.49 | 99 | 19 | 18.28 |
| Chamberlain, S. Dak.—Chicago, Milwaukee and St. Paul Railway water tank | 1,427.697 | | | | | | |
| Chamberlain, S. Dak.—Chicago, Milwaukee and St. Paul Railway depot | 1,431.993 | | | | | | |
| Chamberlain, S. Dak.—Center of Main and Clemens streets | 1,464.314 | | | | | | |
| Chamberlain, S. Dak.—Hydrant at southwest corner Main and Clemens streets | 1,467.577 | | | | | | |
| Chamberlain, S. Dak.—Taft House | 1,486.815 | | | | | | |
| Chamberlain, S. Dak.—High School | 1,540.599 | | | | | | |
| 282 | 1,525.932 | 43 | 48 | 21.20 | 99 | 19 | 50.11 |

### REPORT OF MR. F. M. TOWAR, ASSISTANT ENGINEER.

SIOUX CITY, IOWA, *July 1, 1893.*

CAPTAIN: At the end of the fiscal year, June 30, 1892, party No. 1 of the Missouri River Survey, in charge of Assistant Engineer F. W. Lightner, had reached Fairbank, S. Dak., having commenced on May 23 at Cannonball, N. Dak. This party carried only the tertiary triangulation, the primary levels, and the bluff topography, leaving the hydrography, the slope and shore lines of the river, and topography of the bottom lands for a supplementary party to follow later in the season.

The party reached Chamberlain, S. Dak., late in August, when, on account of the low stage of the river, it was thought advisable to add to it a level party, a hydrographic party, and an additional topographic party, so that from here down the slope, the depth, and shore lines of the river would be added to the other features, making a complete survey from Chamberlain to Sioux City, Iowa.

About this time (the latter part of August) party No. 2 was organized to follow and complete that part of the survey between Caunonball and Chamberlain left undone by the preceding party, viz, the hydrography, the levels to obtain the slope of the river, the shore lines of the banks and sand bars, and the general topography of the bottom lands.

The object of dividing up the parties in the foregoing manner was to obtain the soundings, the slope, and the shore lines of the river as near to low water as possible.

Party No. 1 reached Sioux City November 10, having made a complete survey from Chamberlain, excepting some topography between Yankton and Sioux City, which is now being done and is nearly completed.

Party No. 2, in charge of Assistant Engineer C. W. Williams, failed to reach Chamberlain and make connection with the work of the other party, reaching Crow Creek Indian Agency, 20 miles above Chamberlain, when the river closed, leaving the shore-line levels and soundings in this short stretch of river incomplete.

The field work of the river survey from Fort Benton to Sioux City, with the exceptions noted, is now complete.

### OFFICE WORK.

Computations of the tertiary triangulation covering the river from Cannonball to Sioux City have been completed since the return of the field parties in November last. Nine hundred and eighty-seven triangles have been computed, from which the coördinates of the following points have been deduced, viz, 580 triangulation stations in the regular scheme, 248 bench marks, and numerous other comparatively permanent objects along the river, such as churches, school-houses, court-houses, and flag-staffs at military posts. These points will be plotted on 84 detail charts, 69 of which number have been projected and plotted already.

Computations have also been made of the coördinates of 1,076 miles of stadia lines and the results compared with coördinates derived from the tertiary triangulation, the stadia discrepancy being proportionately distributed in the courses, the discrepancies in the tertiary triangulation as compared with the secondary work having been previously adjusted so as to agree with the latter. The geographical positions of the points in the secondary triangulation are accurately determined.

The 59 detail charts in progress at the end of the last fiscal year have been nearly completed and in addition there were projected 69 new charts, 56 of which are about one-half complete; the remainder are having the triangulation and the stadia points plotted on them. There are yet to be projected 15 of these charts to complete the mapping to Sioux City.

The work of drawing the small scale charts has been continued. Eight and one-half of these charts were completed during the year, extending from Judith River, Montana, to Williston, N. Dak., a river distance of 478 miles. These charts are now about one-third done, 10 being completed out of a total number to carry the work to Sioux City of 29. It will be seen by the foregoing that the mapping of the detail charts is about complete from Fort Benton to Cannonball, 886 miles, and the remaining 598 miles to Sioux City about one-third done.

The following table gives the amount of the several branches of survey work done during the year:

| | |
|---|---|
| Miles of river surveyed | 578 |
| Square miles topography | 830 |
| Points located to plot topography | 58,730 |
| Number of triangles closed | 987 |
| Bench marks established | 248 |
| Number of soundings taken | 267,500 |

Appended is a table of river distances from Cannonball to Crow Creek Indian Agency.

Very respectfully, your obedient servant,

F. M. TOWAR,
*Assistant Engineer.*

## REPORT OF MR. H. C. GOULD, ASSISTANT ENGINEER.

SIOUX CITY, IOWA, *July 1, 1893.*

SIR: I have the honor to submit the following report relative to water gauges, operations on the rocky portion of the upper Missouri River, and repairs to snag boats during the year ending June 30, 1893.

### WATER GAUGES.

The following list gives the stations from which reports were received during the year, character of gauges, and other details:

*Townsend, Mont.*—Reports from this gauge have been regularly received all the year, through the courtesy of the Missouri River Commission, by whom the gauge is operated. It is a standard bridge cable gauge, described in the Missouri River Commission report for 1891. Distance above Sioux City is 1,703 miles.

*Fort Benton, Mont.*—This is a standard bridge cable gauge. The record is complete for the year. I inspected and tested the gauge September 21, 1892, and found it to be correct. Distance above Sioux City is 1,484 miles.

*Judith, Mont.*—This was a wooden inclined gauge set flush with the surface of the bank slope in November, 1891, and was read by the watchman of the fleet laid up there. Early in June, 1892, the gauge was destroyed by the cutting away of the banks; after that the watchman kept a record, by placing temporary staff gauges, up to November 12, 1892, and from April 5, 1893, to June 30, 1893. Distance above Sioux City is 1,397 miles.

*Wolfpoint, Mont.*—This is a vertical staff gauge, established July 8, 1891. Bench marks were placed near by, so that it has been readily replaced when disturbed by ice or high water. During the year the record has been continuous, except from October 29, 1892, to April 9, 1893, when the river was closed by ice.

I inspected and tested the gauge September 23, 1892, and found the zero had been raised 0.13 foot since first established. This change undoubtedly occurred June 29, 1892, when a new staff was set up by the keeper, the old one having been carried away on June 19, 1892, by a caving of the bank. Distance above Sioux City is 1,089 miles.

*Fort Buford, N. Dak.*—This is a form of cable gauge, the cable and weight being suspended from a light beam, stiffened by wire guys; the beam is placed horizontally on a four-wheeled carriage, which runs on a plank track at right angles with the river bank. A counterweight is placed on inner end of beam. To take observation the carriage is run out to the end of the track against a stop, the weight is lowered to the water surface and the reading taken from a scale on the beam.

The record is complete for the year, except from December 17, 1892, to April 6, 1893.

I inspected and tested this gauge September 24 and 25, 1892, and found it in apparently the same condition as when inspected September 13, 1891, by Mr. F. W. Lightner, chief of survey party, except that the zero had raised 0.32 foot. I judge this change was gradual during the year intervening, resulting from the weakness of the apparatus.

To afford means by which the observer could readily check the gauge readings, I set three solid marks at different heights down the slope, under the gauge, and gave the observer the heights of these marks above the gauge zero. He measures directly the vertical distance of the water below the nearest mark at least once a week, and is thus enabled to keep the gauge readings correctly. Distance above Sioux City is 957 miles.

*Bismarck, N. Dak.*—This is a bridge cable gauge, but operated in a different manner than the standard cable gauge. The cable and weight is used to measure the distance from the water to the track stringer, the elevation of which above sea level is approximately known by the railroad levels.

The record is complete for the year. The gauge was last inspected October 16, 1891, by Assistant Engineer G. W. Wood, who found it practically correct and well operated. Distance above Sioux City is 649 miles.

*Running Water, S. Dak.*—This gauge was established by direction of your predecessor on May 10, 1892. The lower part was inclined, fastened to wooden stakes at about the bank surface; the upper part was vertical and bolted to the face of a loose chalk rock bluff. On July 10, 1892, at the height of the regular summer rise, the upper part was broken down and the lower part covered by a slide of the bluff face.

The gauge record was interrupted from that date to August 14, when the lower part was uncovered and found not disturbed. On September 30, 1892, a new gauge was erected and the zero raised 2 feet. The new one is a form of the cable gauge; the cable and weight are suspended from a horizontal beam 8 inches by 10 inches, fastened to two heavy piles set in top and near edge of the bank. The outer end is held from sagging by a truss rod passing over a short vertical post. The record was continued until the river was closed by ice, December 15, 1892. When the river opened March 11, 1893, it was resumed again and continued to the end of the year. The gauge was moved twice this year on account of cutting away of the bank, but the same elevation of zero was preserved. Distance above Sioux City is 136 miles.

*Sioux City, Iowa.*—This is a standard bridge cable gauge, operated by the Missouri River Commission. The reports have been regularly received all the year through courtesy of the secretary of the commission.

The gauge reports are received weekly on blanks provided by this office. The readings are copied on monthly sheets and bound, for better preservation and reference, and are also plotted on hydrographs; apparent errors are immediately corrected by correspondence or otherwise.

The observers copy the record into a book specially prepared and furnished for that purpose. At the end of each year or season the books are returned to the office, and the records therein compared with the record made from the weekly reports.

The changeable character of the banks of the Missouri River and the scarcity of bridges above Sioux City, make the establishment of a sufficient number of permanent gauges extremely difficult. No style of gauge yet tried has been satisfactory, except, of course, those on bridges. The design of a movable trussed beam cable gauge to be placed on the top of the bank is nearly completed, which is believed will meet the required conditions.

### CONDITION OF "ROCKY" RIVER IMPROVEMENT.

No work has been done on this part since that from near Fort Benton to Judith in 1891. In September, 1892, I was directed to make an inspection of these works in connection with the inspection of gauges and an investigation of the burning of the dredge at the mouth of Eagle Creek.

*Bakers Bar.*—The large dam in left hand chute was still in good condition, and has done very effective work in closing the chute; large deposits of gravel and silt were found in the chute above the dam and on the head of the island. The fill below the dam has also been extensive.

At this time, the Benton gauge reading 1.2 feet, the difference in height of water above and below the dam was 2¼ feet.

In the bend of the main river below head of the chute the right bank is still cutting badly. Just above the lower end of the island where the shoalest water has existed the conditions were not so favorable as the year before. The left bank has commenced to cut away and the water has spread out more. The best depth found was only 1.5 feet.

*Shonkin Bar.*—The dams here were found to be in about the same condition as in 1891. The depth on crossing was 1.8 feet.

*Evans Bar.*—This dam was in very good condition. The small chute at upper end of dam was entirely closed up and large deposits of gravel have been made just below the dam. The small dam in right bend was in good shape. The depth on crossing near it was 2 feet. At lower end of island considerable filling has occurred, but the channel depth has improved to 3 feet.

*Crocondunez.*—Much change has taken place here. The main current was found striking the lower end of the large dam built in 1889, cutting away a large part of it, and deflecting across into the right bank below, was cutting there. The wing dam on right side lower down at the dredge cut made in 1889 was nearly all washed out and most of the water was going over its site at a depth of 2 feet. The channel of the year before around left end of dam was nearly filled up. Just below a new bar had formed, over which only 15 inches were found, but this will probably cut out deeper, as it was only a narrow ridge.

*Fontanelle Bar.*—All the work here was found in good condition, except at the upper end of the large dam across head of chute on left side, where a large hole had been washed through during the high water of 1892. This hole was filled up in December, 1892, by arrangement with Mr. James Rowe, at an expense of $100. Watchman Kelly, who had been foreman on similar work, went up from Judith to direct it. The small spur dams built in 1891 to stop cutting of the left bank just below the dam had accomplished their purpose, no more cutting having taken place. The depth on the Fontanelle crossings was 3 feet.

*Senieurs Reach.*—The three dams here were still intact and in about the same condition as for the last two years.

*Archers Bar.*—The wing dams on right bank built in 1891 were in excellent condition. In the dredged cut opposite the dams the least depth was 2.5 feet.

*Churchills Bend.*—The depth through the cut dredged in 1891 was 3.2 feet.

*Crow Coulee.*—The low dam built across the left-hand chute was cut through at the left end and about 30 feet of it gone. The depth through the dredged cut in right chute was 2 feet.

*Judith.*—The dam across chute around Norris Island was in very good condition and had caused extensive deposits of silt and gravel above it. The bank on right side opposite bar had been cut away badly, the gravel bar had grown upstream, and depth on crossing was the same as last year, 2 feet.

### BURNING OF DREDGE.

At the close of work in 1891 the dredge had been hauled out on the bank about 1,000 feet above mouth of Eagle Creek (35 miles above Judith).

On Sunday, July 31, 1892, about 3 p. m., fire broke out in the hold and the boat was entirely destroyed.

Investigation of all the circumstances and evidence that could be gathered resulted in the conclusion that the fire was started by spontaneous combustion among some new waste stored in the hold or among oiled waste or rags which might have been overlooked in cleaning the boat.

The main engines and swinging engines are all worthless. The timbers about them were thoroughly saturated with oil, making the fire there the hottest. Much of the cast iron about them is melted and other parts warped and broken. The capstan engines are ruined. Some pieces of the capstan might be used again, but even the large, heavy spindles are bent. A few sheaves and other parts of the turntable, spud-hoisting apparatus, and A-frame can also be used. The hog chains and their fastenings are all good, but badly bent up. The boiler is apparently all right. It was entirely covered with brick, and, being in the newer part of the boat, where timbers were not oil-soaked, it was not subjected to such great heat as the rest of the machinery.

I had the boiler rolled out of the ruins on higher ground and entirely inclosed by a good shed. Most of the smaller pieces worth saving were put in the shed.

The barge, with hoisting engine, which had been hauled out with the dredge, was not burned, as it had been launched a few days before by the watchman, who had been preparing, under instructions from this office, to move all the loose property to Judith. The rest of the small articles worth saving, some way timbers and other property, were loaded on this barge and it was floated to Judith. Later the barge was hauled out on the bank there.

### FLEET AT JUDITH, MONT.

Most of the fleet laid up here in 1891 had to be twice moved back from the bank on account of its unexpected cutting away by the water.

There appeared to be little prospect that the plant would soon be needed again in that part of the river, and it will be much needed lower down. By your direction preparations were commenced early in June, 1893, to bring the fleet and property down to Bismarck. A party of boat carpenters and calkers, under a competent master carpenter, were sent to Judith to repair and launch the boats.

They arrived at Judith June 21, 1893. At the end of the month the work had progressed so far that they expect to be ready to start about July 12. The fleet to be brought down consists of the small steamboat *Josie*, a large quarter boat, a store boat 65 feet long, four 65-foot barges, one 50-foot barge, and three 40-foot barges. The derrick boat, condemned last year, is to be broken up and the machinery brought down on the barges.

### REPAIRS TO SNAG BOATS JOSEPHINE AND MANDAN.

During last December these boats were hauled out at Yankton for extensive repairs and alterations. The *Josephine* was to have a new bow and the *Mandan* was to be lengthened and provided with propelling power and its necessary accessories. During the winter the detailed plans were worked out and arrangements made for beginning work as early as practicable after danger to the boats from ice gorges was past.

The best bid on about 18,000 feet of oak lumber for the *Josephine* repairs was received from the Towle mill at Metropolis, Ill., being $27 per M on cars at that place. An attempt was made to purchase the frames already sawed to shape, but the prices asked were so high that material for the frames was included in the bill of oak lumber; full-sized patterns were gotten out here and the frames were sawed to shape at a Sioux City mill.

The work of taking off the old bow was commenced about April 1; about 40 feet of the old hull was removed entirely and was found badly decayed; some of the keelsons had to be removed for some distance farther back. The new bow, molded spoon shape, was made 5 feet longer; its head is 14 feet wide across the front, which is concaved, has 2½ feet of solid oak, and is to be covered by steel plate three-eighths inch thick. A truss of 5 inches by 6 inches oak and three-quarter-inch iron rods, was built in the middle, extending 90 feet back; a solid cross bulkhead was put in under the shears. The capstan engines were moved close up to the longitudinal truss, strongly bolted to it and to bottom of the boat; new and stronger foundations for the capstans were made. The old shears had proved too small and larger ones were obtained made of 8-inch diameter steel Phœnix columns. The fastening of the shear guys was changed from the deck to the top of the posts at the roof opposite the pilot house, the posts being held by an iron pipe stretcher between their tops and iron rod guys to the deck. The pilot house was raised 2 feet to give the pilot a better view of the deck. The wheel was entirely rebuilt, with arms and plank of oak and circles of iron.

The *Josephine* was launched June 2, and the repairs practically completed June 15.

The work of lengthening the steel hull of the *Mandan* 48 feet and erecting the cylinder beams and wheel guards, requiring about 60,000 pounds of best mild steel in plates, angles, and rivets, was awarded to F. Spencer, of this city, after competition by circular notices, at 9 cents per pound for material in place, all preparatory work to be done by the United States.

He commenced work at the boat about April 11. The hull was so far finished that she was launched June 15, and she was towed to Sioux City by the *Josephine* June 19 and 20.

On June 30 Spencer still required about two weeks to finish his contract.

The carpenter work on extension of house was commenced June 27. The old house was moved back 12 feet to give more room on the forecastle.

The furnishing of the engines was awarded to the Haley Foundry and Machine Company, of this city. They are of the compound type, the high-pressure cylinder (7 inches diameter) being within the low-pressure cylinder, which is 14 inches in diameter. This makes the low-pressure cylinder piston an annular ring, having an outer diameter of 14 inches and an inner diameter of 8¼ inches. The stroke is 4 feet. The price for two engines, wheel shaft 5¼ inches diameter, and all wheel irons, all pipings and fittings complete in place ready for trial trip, is $2,700. On June 30 they were nearly completed and ready to be set up as soon as the cylinder beams are ready.

The boiler is to be the Roberts safety water-tube boiler, made at Red Bank, N. J. The size is No. 12, 8 feet long, 6 feet high, and 6 feet wide, 28 square feet of grate surface. Cost at works is $1,680. The boiler was ready for test on June 30.

The Providence capstans were worn out last season and proved too light for snagging work. Two new capstans, nearly like those on the *McPherson* and *Josephine*, were obtained from the Iowa Iron Works, Dubuque, Iowa, at a cost of $750 at Dubuque.

Each capstan is run by a pair of 7½ by 10 inch link-motion engines, made by the Lidgerwood Company, Brooklyn, N. Y. The cost for the two engines is $975 at Brooklyn. The capstans and engines were received during June.

The wheel is 14 feet diameter, 15 feet long, has four flanges with 14 arms in each; the buckets are 16 inches wide. The pitmans are 19¼ feet long.

The dimensions of hull as completed are: Length, 138 feet; width, 24 feet; depth, 5 feet in middle, and 4¼ feet on sides. The rake on bow is 16 feet; on stern, 11 feet.

Very respectfully, your obedient servant,

H. C. GOULD,
*Assistant Engineer.*

Capt. H. F. HODGES,
*Corps of Engineers, U. S. A.*

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## C C 2.

## REMOVAL OF SNAGS AND OTHER OBSTRUCTIONS IN MISSOURI RIVER, ABOVE SIOUX CITY, IOWA.

### PROJECT.

The approved project contemplates the use of the available funds in the work stated on that part of the Missouri River above Sioux City where boats may be running and where the work is most needed.

### APPROPRIATIONS.

But one appropriation has been made for this work, viz, by the sundry civil bill of March 3, 1893, $50,000.

### OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1893.

Nothing has been done during the year under this appropriation, as the funds did not become available until July 1, 1893. The work of the snagboats has been carried on under the general appropriation for improving the Missouri River between the Great Falls, Mont., and Sioux City, Iowa, and will be found reported under that head.

*Money statement.*

| | |
|---|---|
| Amount appropriated by sundry civil act approved March 3, 1893 | $50,000.00 |
| July 1, 1893, balance unexpended | 50,000.00 |
| Amount (estimated) required for completion of existing project * | 50,000.00 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895 | 50,000.00 |
| Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893. | |

## C C 3.

### EXAMINATION OF MISSOURI RIVER FROM THREE FORKS TO CANYON FERRY, MONT., WITH A VIEW OF DETERMINING AT WHAT POINTS, IF ANY, USE MIGHT BE MADE OF WATER POWER FOR MANUFACTURING AND OTHER PURPOSES WITHOUT UNREASONABLY IMPAIRING THE NAVIGABILITY.

### PROJECT.

This part of the river was surveyed and mapped in 1890 under the direction of the Missouri River Commission. For the present work it is proposed to examine the maps of this survey, to select such points as seem suitable, to personally examine the localities, and by additional field work to get the necessary data for a report.

### APPROPRIATION.

| | |
|---|---|
| July 13, 1892 | $2,500 |

### PROGRESS DURING THE YEAR.

The personal examination of the locality has been made by the officer in charge of the work. The examination and copying of the maps of the previous survey and the additional field work remain to be done. The low water of early autumn is most suitable for this work, and it has accordingly been left for that season.

*Money statement.*

| | |
|---|---|
| Amount appropriated by act approved July 13, 1892 | $2,500.00 |
| July 1, 1893, balance unexpended | 2,500.00 |

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* Annually.

## C C 4.

## IMPROVEMENT OF YELLOWSTONE RIVER, MONTANA AND NORTH DAKOTA.

### APPROVED PROJECT.

The approved project contemplates rock removal at various places on the river, the construction of closing dams and wing dams at points below Glendive, and a survey of the river. Operations under this project are now suspended.

### APPROPRIATIONS.

| | | | |
|---|---|---|---|
| 1878* | $15,000 | 1882 | $20,000 |
| 1879 | 25,000 | 1884 | 20,000 |
| 1880 | 15,000 | 1886 | 18,750 |
| 1881 | 20,000 | | |

### CONDITION AT BEGINNING OF YEAR.

The expenditures on the river have resulted in giving a depth of 3 feet at the points improved above Glendive and of 3 feet or more at the points improved below that place. The survey has been finished.

### OPERATIONS DURING THE YEAR.

During the fiscal year ending June 30, 1893, no work was done. For reasons given in Appendix X 2 of the Annual Report of the Chief of Engineers for 1887, the project is suspended for further action of Congress.

There has been expended on the river improvement a total sum ot $103,029.13 and on the survey a total sum of $19,000. There was formerly a brisk river traffic, which has been killed by the railroads:

*Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $11,720.87 |
| July 1, 1893, balance unexpended | 11,720.87 |
| July 1, 1893, outstanding liabilities | .71 |
| July 1, 1893, balance available | 11,720.16 |

## C C 5.

## PRELIMINARY EXAMINATION OF JAMES RIVER, SOUTH DAKOTA.

ENGINEER OFFICE, U. S. ARMY,
*Sioux City, Iowa, February 28, 1893.*

GENERAL: I have the honor to report, from preliminary examinations made by me and by Assistant Engineer F. M. Towar, whose report is herewith, that the James River in South Dakota is not now worthy of improvement by the General Government, and for the following facts and reasons:

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* Allotment for survey from appropriations for examinations and surveys.

The river throughout is very crooked; the volume is small; at ordinary stages the channel is narrow, and is obstructed by overhanging trees, many shoal places, and several dams and low bridges. The need for transportation on the river is not apparent.

It is judged that the bends of the river lengthen its course fully 50 per cent. There are 12 railroad bridges over the river; a new railroad is being built from Sioux Falls to Yankton which must also cross the river. There are 22 wagon bridges and 9 dams across the river in 6 out of 8 counties, reports not having been received from 2 counties. All the bridges are low, without draws, and are generally pile structures. The dams are about 7 feet high, some less; a very few as high as 9 feet, and one 11 feet high. There are fair depths of water only in the lower parts of the ponds above the dams. To make these depths nearly continuous would require very extensive dredging or the raising of present dams or building new ones, and for through navigation numerous locks or lifts for passing boats.

The most serious difficulty in navigation is the insufficiency of volume of water for even light-draft boats, especially during the period between harvest and winter, when any navigation wanted would be wanted the most.

Investigation did not show any practicable means for creating reservoirs for increasing the low-water volume. It is possible that the future artesian well waste may augment the river flow sufficiently; when that condition obtains the securing of the navigability of the river will be an easier problem. At present the total artesian flow in the James River basin is approximately 400 cubic feet per second. It is understood that part of the flow of a few of the wells is shut off at times. It further appears that effort is made, for reason of climatic influence, to run the water into old lake beds and depressions for keeping them filled. Assuming then, according to the general rule, that one-third of the irrigating water, for which the remainder is principally used, reaches the main drainage channel, the augmentation to the volume of the James would be very small.

Verbal inquiries were made of residents and written ones addressed to mayors and postmasters of contiguous towns and to chairmen of boards of county commissioners, as to the effect of the artesian wells on the volume of the James. The consensus of opinion is that the effect is inappreciable.

The supposed source of the Dakotan artesian supply, which to my mind is best supported by the results of observations and the more reasonable theories, has been found to be in volume 834 cubic feet per second; a part of the supply is tapped exterior to the James River valley. On the whole it may be concluded that an expectation of any considerable augmentation of that river's volume from artesian well waste is not promising, and that under present conditions the improvement of the James River for rendering it navigable beyond short and isolated stretches would be a matter of great cost.

The river was examined by Major Farquhar, Corps of Engineers, in 1874 and by Captain Sears, Corps of Engineers, in 1886. The latter officer reported:

> In my opinion no general through improvement, giving access to the Missouri River, is practicable. It is barely possible that, with an extraordinary and totally unreasonable expenditure, a slack-water navigation of locks and dams might be secured, though the engineering difficulties at the mouth are almost insurmountable.

Assistant Ainsworth, in his report to Major Farquhar, says of the mouth of the James: The Missouri at the mouth of the Dakota (James) was in good navigable stage, but the appearance of the latter was anything but promising, as its mouth had been sealed up by the deposits of the Missouri while in flood. The river here was from 75 to 100 feet wide and from 3 to 8 inches in depth, with considerable fall over a bed of mud 3 feet deep and of the consistency of mortar. I found in November, 1886, still less water and considerably more mud. If it were possible to build a lock here, dredging in the tailbay would have to be kept up continuously to keep open the entrance.

The James is probably one of the most crooked rivers in the world. It is over 1,000 miles in length in an air-line of 300 miles. This fact would add immensely in cost to any scheme of slack-water navigation.

Assuming the engineering difficulties overcome, there is a very strong and reasonable doubt whether there would be enough water to supply even a limited number of lockages per day. Assuming sufficient water, the canal could be used only six months in the year. From the middle of October to the middle of April it would be liable to be frozen.

Another item of expense would be the actual damages to be paid by the United States to corporations, counties, and riparian owners for obliging them to put draws in bridges and to remove dams, or for lands overflowed on account of new dams.

Captain Sears further reported that he fully agreed with Major Farquhar "that the river [the James] can not be made navigable by the ordinary means of improving the natural channel, for the reasons that there is not a sufficiency of water and that the river is too tortuous," and that in his opinion the river is not worthy of improvement.

Now, as to the need of transportation on the James in South Dakota. There is and has been no effort to navigate the river hardly worth mentioning. About twelve years ago a small stern-wheel boat was placed on the river near Columbia, in the northern part of the State, and run there for a short period until railroads penetrated that region, when the boat was dismantled and her hull allowed to go to wreck. A launch is used at Huron during summer for excursions.

Navigation by small barges and steamers is not impracticable on stretches of a few miles each above the dams and above the mouth of the river. More than half the dams are for water power for flour mills, but no effort to carry wheat by boats to the mills has been noticed. Neither have I been able to learn that any Missouri River steamer has gone into the James, which could be readily done for a few miles when the Missouri was high; nor that owners of Missouri River boats considered there was business for them up the James. The lower part of the James River approximately circles from the northeast through the east around Yankton, making only a good 4 miles to town from the two railroad bridges farthest down stream, while from that point via the James and then up the Missouri is nearly 30 miles. The fact is that at these local routes, the farmer having his wagons, teams, and help hauls over the short roads and neither he nor the miller or merchant has occasion to seek boat transportation.

The James River in South Dakota is paralleled and crossed by the lines of three large rail systems, giving direct connections with the primary markets of the Northwest for grain and live stock; these products are by far the principal ones of the valley. The map tracing herewith shows the network of the railroads which provide present transportation for the valley.

A table of rail rates on grain and small stock for valley points is appended. An inspection of this correct table and a consideration of probable boat rates via the James and Missouri to Yankton or Sioux City, supposing that continuous navigation on the James into the Missouri were made practicable, does not show anywheres near enough difference of rates to cover the water transportation.

Means of Missouri River boat rates to Sioux City from Pierre and Charles Mix County landings, South Dakota (which routes are about as long as by river from Columbia and Huron in the James River Valley, respectively), are, for grain, 20; sheep, 36; and hogs, 31 cents per 100 pounds.

Chicago is the principal and highest priced market; taking rates there as a basis and those of cases from the table of rail rates most favorable for competitive river freightage, there results—

| | Wheat. | Corn. | Hogs. | Sheep. |
|---|---|---|---|---|
| | *Cents.* | *Cents.* | *Cents.* | *Cents.* |
| To Chicago from Columbia | 30 | 27½ | 44 | 44 |
| To Chicago from Yankton | 28 | 27½ | 31 | 34 |
| Difference | 2 | ........ | 13 | 10 |
| Probable boat rates, James River points to Yankton | 16 | 15 | 27 | 23½ |
| To Chicago from Columbia | 30 | 27½ | 44 | 44 |
| To Chicago from Sioux City | 25 | 20 | 22 | 30 |
| Difference | 5 | 7½ | 22 | 14 |
| Probable boat rates, James River points to Sioux City | 20 | 20 | 36 | 31 |

Taking Duluth as the basis for comparing grain rates, the showing is still less favorable for boating to Sioux City and rail from thence to Duluth, or, Sioux City being a packing point, a live-stock dealer marketing there from James River points would find the rail rates less than probable boat ones. The same conclusion applies to grain shipments to Yankton or Sioux City mills.

Lumber and coal are the main articles of heavy traffic shipped into the James River country. The coal goes from lake ports or from the interior of Iowa. From each set of shipping points named the distance of rail haul is so much less to James River points than to the Missouri River at and above Sioux City, plus the river distances to destination that probably there would be no extensive James River transportation of these articles. Lumber goes from Minneapolis, Stillwater, and adjacent places, from which the rail distances to James River points are about equal, thereby probably leaving no amount ot profitable boating on James River worth mentioning.

Very respectfully, your obedient servant,

Chas. F. Powell,  
*Captain, Corps of Engineers.*

Brig. Gen. Thomas L. Casey,  
*Chief of Engineers, U. S. A.*

(Through Col. O. M. Poe, Corps of Engineers, Division Engineer, Northwest Division.)

[First indorsement.]

U. S. Engineer Office,  
*Detroit, Mich., March 20, 1893.*

Respectfully forwarded to the office of the Chief of Engineers.

For the reasons stated by the district engineer, I concur in his opinion that James River, in South Dakota, is not now worthy of improvement by the General Government.

O. M. Poe,  
*Colonel, Corps of Engineers, etc.,*  
*Division Engineer, Northwest Division.*

*Railroad rates (in cents per 100 pounds).*

| From James River points in South Dakota. | To— | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Minneapolis. | | | | Duluth. | | | | Chicago. | | | | Sioux City. | | | |
| | Wheat. | Corn. | Hogs. | Sheep. | Wheat. | Corn. | Hogs. | Sheep. | Wheat. | Corn. | Hogs. | Sheep. | Wheat. | Corn. | Hogs. | Sheep. |
| Columbia | 20 | 20 | 27½ | 27½ | .... | .... | .... | .... | 30 | 27½ | 44 | 44 | .... | .... | 27 | 30.4 |
| Putney | 20 | 20 | 24 | 24 | 20 | 20 | 24 | 24 | .... | .... | .... | .... | .... | .... | .... | .... |
| Bath | 20 | .... | 27 | 27 | .... | .... | .... | .... | 30 | .... | 43 | 43 | 23 | .... | 28.1 | 25 |
| Aberdeen | 20 | 20 | 25 | 25 | 20 | 20 | 25 | 25 | .... | .... | .... | .... | .... | .... | .... | .... |
| Ashton | 20 | .... | 27½ | 27½ | .... | .... | .... | .... | 30 | .... | 43 | 43 | 20½ | .... | 26.1 | 23½ |
| Redfield | 20 | 20 | 27½ | 27½ | .... | .... | .... | .... | 30 | 27½ | 42½ | 42½ | .... | .... | 23 | 25.9 |
| Huron | 23 | 23 | 24 | 21½ | 25½ | 25½ | 21.2 | 21.2 | 30 | 27½ | 40 | 40 | .... | .... | 21½ | 24.2 |
| Woonsocket | 23 | .... | 27½ | 27½ | .... | .... | .... | .... | 30 | .... | 39 | 39 | 17 | .... | 22½ | 23 |
| Mitchell | 21 | 20 | 25 | 25 | .... | .... | .... | .... | 29 | 27 | 37 | 37 | 18 | 15½ | 21 | 21 |
| Burton | 21 | .... | 30 | 27½ | .... | .... | .... | .... | 28 | .... | 34 | 36 | 16 | .... | 21 | 21 |
| Menno | 23 | .... | 30 | 30 | .... | .... | .... | .... | 27 | .... | 32 | 35 | 13 | .... | 17½ | 18½ |
| Yankton | 22 | 19 | 27½ | 27½ | .... | .... | .... | .... | 28 | 27½ | 31 | 34 | 10½ | .... | 14½ | 14½ |
| Sioux City | 18 | 15 | 20 | 20 | 22½ | 17½ | .... | .... | 25 | 20 | 22 | 30 | .... | .... | .... | .... |

## REPORT OF MR. F. M. TOWAR, ASSISTANT ENGINEER.

ENGINEER OFFICE, U. S. ARMY,
*Sioux City, Iowa, December 26, 1892.*

CAPTAIN: In compliance with your instructions, I proceeded from Pierre, S. Dak, on October 12, to make an examination of James River, at Huron, Redfield, and Columbia, S. Dak.

On the 13th, at Huron, I conferred with Mr. Richards, president of the Consolidated Land and Irrigation Company, and with the mayor of the city. I asked the latter his opinion of the possibility of improving the river, with a view to making it navigable. He laughed at the idea of navigation on the James River, and said that at his farm, 5 miles below Huron, in one place he could walk across the bed of the river without getting his feet wet. Mr. Richards did not think that the river could be made navigable; on second thought, however, would like to see some money spent on it.

The dam at Huron, with a fall of 4 or 5 feet, built by the Northwestern Railway Company to supply their water tank, backs the water up for a considerable distance, forming a pond or lake, enabling a small steamer, with a draft of about 14 inches, to go up a distance of 10 miles, carrying excursion parties to a summer resort.

The banks of the river at Huron are from 5 to 15 feet high, the river from 50 to 75 feet wide, the current sluggish, running about 30 feet per minute. I should think the river discharged at this place from 50 to 60 cubic feet per second.

The bottom is composed for the most part of mud. At intervals, however, there are gravel and rocky shoals, where the river widens out, the current runs swifter, and there is less than a foot of water, the average depth of the deep portions of the river being about 5 feet.

There are two bridges across the river at Huron, the iron bridge of the Chicago and North-Western Railroad and a pile bridge 300 feet below it.

At Redfield the banks of the river are very much the same as at Huron (about 10 to 15 feet high); the river is 50 feet wide and very sluggish and crooked. Here I consulted with one of the aldermen of the city and a hardware merchant. The latter, who is an old settler, said that in the early days, before bridges were available, a good deal of difficulty was experienced in finding fords, and in some years it would be as late as September 1 before the water would be sufficiently low to ford. He also doubted the possibility of extended navigation of the river. The average depth of the river here at low water is about 5 feet.

At Columbia there is a mill and dam. The water passing over the latter falls 11 feet, and, having a volume of about 50 cubic feet per second, forms a good water power. The mill, however, has not been running for several years.

A small steamer used to run up the river from Columbia, carrying excursion parties to the foot of a rapid about 40 miles above the town, but this boat has not been in commission for several years.

The river below the dam at Columbia is from 35 to 50 feet wide, and the banks are from 15 to 30 feet high. The depth of water averages 4 feet.

Just below the dam at Columbia is a bridge and another down about 5 miles. I was informed that a bridge is built across the river at almost every township line in this part of Dakota.

A farmer living 6 miles below Columbia informed me that in 1891 the bed of the river 20 miles below Columbia was used as a wagon road for a considerable distance, and that there was no current in the stream above. Between Redfield and Columbia large trees with overhanging branches, meeting from either side 40 feet above the surface of the water, would obstruct navigation until removed.

I met the chief of a topographical party working for Major Powell, of the Interior Department; he informed me that the slope of the river averaged about 6 inches to the mile.

*Artesian wells.*—Mr. Richards, of the Consolidated Land and Irrigation Company of Huron, informed me that his company had three large wells, the largest of which discharged through a 6-inch pipe 2,000 gallons of water per minute (about 5 cubic feet per second), with a pressure of 200 pounds to the square inch; the other two have a somewhat smaller flow, discharging 1,600 to 1,800 gallons per minute, with a pressure of 170 pounds. The well that supplies the city of Huron with water is also of large volume, having a pressure through a 6-inch pipe of 170 pounds. Mr. Richards, when asked what effect he thought the artesian wells would have on the volume of water discharged by the James River, said it would materially increase it; that although the great part of the water would be used in irrigation, there would always be a loss that would find its way to the river, as well as some of the water used for irrigation would eventually get to the river.

At Redfield I talked to the man in charge of the artesian well that supplies the city with water, and he was of the opinion that the wells would not materially effect the volume of the river; he said they were always kept shut off, only being allowed to discharge as much as was needed for water supply. I saw a large well at Redfield discharging at its full capacity, and there was a torrent of water running away from it; this of course was all running into the James River.

The water from all these wells used for supplying cities along the river reaches the river through sewer and waste pipes, and all that used for water power also, except where it is used for irrigating after having been used for power.

There are about 100 of these wells at present in the James River Valley capable of discharging an average of 3 cubic feet each per second, aggregating a volume of 300 cubic feet, about four or five times the amount discharged by the river itself at low water.

The artesian basin underlying the James River Valley seems in extent to cover about the same as the valley itself, for, while no failure has ever been made in finding water within the limits of the valley, repeated failures are recorded where wells have been sunk outside of that limit.

At Yankton, artesian water is reached at from 650 to 700 feet below the surface, while at Huron the wells are from 950 to 1,000 feet, and at Redfield about 1,100 feet deep.

In conclusion I would say that the James River is not worthy of improvement, for the following reasons:

First. The bends are so frequent and sharp that a steamer of any considerable size could not make the turns, even if enough water were obtained to float her.

Second. The amount of dredging necessary to give a channel of 4 feet (a very small depth for so narrow and sluggish a stream) would hardly be warranted by any business in sight, or probable for a great number of years.

Third. Transportation would have to be managed by small barges, towed by a very small steamer, and could hardly amount to more than local traffic, and considering that freight would have to be hauled to and from these barges it is hardly possible that this arrangement could compete with the railroads that parallel the river.

Very respectfully,

F. M. TOWAR,
*Assistant Engineer.*

Capt. CHAS. F. POWELL,
*Corps of Engineers, U. S. A.*

# APPENDIX D D.

## IMPROVEMENT OF OBION RIVER, TENNESSEE, AND OF CUMBERLAND RIVER, TENNESSEE RIVER ABOVE CHATTANOOGA AND BELOW BEE TREE SHOALS, AND THEIR TRIBUTARIES, TENNESSEE AND KENTUCKY.

*REPORT OF CAPT. JOHN BIDDLE, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1893, WITH OTHER DOCUMENTS RELATING TO THE WORKS.*

### IMPROVEMENTS.

1. Obion River, Tennessee.
2. Tennessee River above Chattanooga and below Bee Tree Shoals.
3. Hiwassee River, Tennessee.
4. French Broad and Little Pigeon rivers, Tennessee.
5. Clinch River, Tennessee.
6. Cumberland River, Tennessee and Kentucky.
7. Caney Fork River, Tennessee.

### EXAMINATIONS.

8. Ohio River, between Livingston Point and Tennessee Island.
9. Duck River, Tennessee.
10. Sequatchie River, Tennessee.
11. Hiwassee River, Tennessee.
12. Emory River, Tennessee.

ENGINEER OFFICE, U. S. ARMY,
*Nashville, Tenn., July 12, 1893.*

GENERAL: I have the honor to transmit herewith the annual reports upon the river improvements in my charge for the fiscal year ending June 30, 1893.

Very respectfully, your obedient servant,

JOHN BIDDLE,
*Captain, Corps of Engineers.*

Brig. Gen. THOMAS L. CASEY,
*Chief of Engineers, U. S. A.*

## D D 1.

### IMPROVEMENT OF OBION RIVER, TENNESSEE.

The Obion River flows wholly in the State of Tennessee, and is a tributary of the Mississippi River, which it enters about 1 mile above Hale Point.

This stream is formed by the junction of the north and south forks in the western part of Tennessee, flows in a generally southwesterly direction for about 75 miles to the Mississippi. In its course the Obion receives the overflow from Reelfoot Lake, and about 4 miles above its mouth the waters of the Forked Deer River. At Obion the river is crossed by the bridge of the Newport News and Mississippi Valley Railroad, which has no draw, and consequently forms an obstacle to navigation above that town.

An examination of this stream was made in 1880. (See Report of Chief of Engineers, 1881, pp. 1486–1489). An instrumental survey was made in 1891 from the Railroad Bridge at Obion to the mouth of river, a measured distance of 68.8 miles, having a fall of 27 feet.

The course of the Obion is through a low, alluvial, and well-timbered country, subject to overflow, due, in a great measure to backwater from the Mississippi. It has a width varying from 80 to 200 feet, and a depth generally of over 5 feet at low water, except at certain shoals, where in some places a depth of but 13 inches was found. The shoals are usually caused by obstructing driftwood, which holds sediment in place, and it is thought that the removal of the drift will, in nearly all cases, cause the disappearance of the shoals. The river is also greatly obstructed by snags and overhanging trees. The tortuous course of the river is also a source of difficulty, some of the bends being very sharp, forming loops with narrow necks. At these points "cut-offs" could be made at small cost, nature having in some instances already begun the work. There is but little current to contend against, the river being generally wider at these points. As far back as 1843 surveys were made by the State of Tennessee and considerable work done by the State in clearing the river of surface obstructions, but the advantages gained were but of temporary duration.

The project for the improvement, based upon the survey of 1891 and the estimate of $50,000, consists of clearing the channel of snags, drift, and overhanging trees; constructing wing dams at the most obstructive shoals; straightening the very tortuous channel by cutting through several sharp bends and making the cut-offs sufficiently wide and deep by clearing, grubbing, and excavating; closing the old channel by means of pile and brush dams, in order to secure at low water a navigable channel of not less than 3-foot depth between Obion and mouth of river.

The only appropriation by Congress for improving the Obion River, Tennessee, was that made by act of July 13, 1892, $7,500.

The construction of the derrick and quarter boats necessary for carrying on the work were built at Obion, Tenn., and on October 17 active operations were begun in the channel and continued until the 21st of December, when work was suspended by reason of high water and cold weather. The channel was cleared from Obion to Lane Ferry, about 22 miles, of such surface obstructions as could be reached at the then high stage of water, and was sufficient to give free passage for steamboat chimneys and pilot houses. It was found that the most economical and advantageous disposition that could be made of the large number of fallen trees along the banks and in the bed of the stream was to cut up and remove them so that they could not again be carried during high water into the channel.

Early in March operations were resumed in the channel, working upstream, clearing away the snags that could not be reached during the season of 1892, and cutting through the drift gorges that completely closed the channel at Guy Jones Lake, Caldwell Cut-off, and Sharpes

Ferry. This was successfully done, and on May 3 a small steamer, *Fleischhauer*, with lumber belonging to Mr. C. A. Fleischhauer, also the owner of a lumber mill on the lower river, passed up with two barges from his mills to the landing at Obion. It is reported that about fifty years ago, as a result of some work done by the State of Tennessee, a steamboat passed up the Obion, landing her cargo at the Turnpike Bridge, 5 miles above the town, and returned laden with agricultural products, so that the *Fleischhauer* is the second steamboat known to have reached Obion, and the residents did not fail to express their appreciation of the work done in the channel and thus making steamboat navigation possible, by a public demonstration on the arrival of the boat and her tow:

The following is a statement of the work done:

| | | | |
|---|---|---|---|
| Snags removed | 871 | Trees topped | 363 |
| Snags topped | 1,213 | Sunken logs removed | 109 |
| Trees cut down | 7,738 | Logs fastened to bank | 50 |
| Trees deadened | 7,741 | Drift removed ... cords | 857 |
| Down trees cut up | 1,155 | Brush removed ... do | 49 |
| Down trees removed | 44 | | |

The amount expended, including outstanding indebtedness, during the fiscal year ending June 30, 1893, was $5,466.99.

The work will be resumed as soon as the stage of water permits of an advantageous prosecution of the work.

The commerce of this river is principally lumber, cut by the seven sawmills now in operation on or near this stream. This lumber goes to all points on the Mississippi River, and as no record is specially kept of shipments by river, it is impossible to get any trustworthy data. Mr. W. M. Wilson, a prominent citizen of Obion and largely interested in opening up the river to steamboat navigation, writes this office that—

> Should the work on the Obion River continue until the drift, snags, and bars are removed, it would be a hard job to undertake to estimate the benefits the people on either side of the river, from its banks to 10 miles distant from Obion to its mouth, would derive. I can with safety say, the benefits would run up into the millions of dollars annually; this is no extravagant estimate.

| | |
|---|---|
| Estimate of cost of improving Obion River, Tennessee | $50,000.00 |
| Amount appropriated | 7,500.00 |
| Amount expended, including outstanding indebtedness | 5,466.99 |

### *Money statement.*

| | |
|---|---|
| Amount appropriated by act approved July 13, 1892 | $7,500.00 |
| June 30, 1893, amount expended during fiscal year | 5,454.99 |
| July 1, 1893, balance unexpended | 2,045.01 |
| July 1, 1893, outstanding liabilities | 12.00 |
| July 1, 1893, balance available | 2,033.01 |
| Amount (estimated) required for completion of existing project | 42,500.00 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895 | 10,000.00 |
| Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893. | |

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#### COMMERCIAL STATISTICS.

*Obion River, Tennessee, from July 1, 1892, to June 30, 1893.*

| | |
|---|---|
| Lumber ... tons | 16,200 |

This commerce represents the tonnage brought up the river to Obion from a point about 23 miles below, and rendered possible only by the improvements made during the present fiscal year.

## D D 2.

## IMPROVEMENT OF TENNESSEE RIVER.

(Length, 673 miles.)

The exact point at which the Tennessee River has its origin is still a matter of some uncertainty. The Riviere des Oberaquis, or Cherake, of the early French explorers, and the Cherokee River as referred to in cessions to the English by the Indians in 1767, has been considered as being formed by the junction of what are now called the Little Tennessee and Holston rivers, near the town of Lenoirs, Tenn. Tannassee, the chief town of the Cherokee Indians, was situated near this point, and the fact that the river derives its present name from that town seems to add additional weight to the arguments of the geographers who have placed the head waters of the river at this junction. In some of the older geographies the head of this river has been placed at the mouth of the Clinch River.

Legislature of the State of Tennessee in 1889 passed an act declaring "that the Tennessee extends from its junction with the Ohio River at Paducah, in the State of Kentucky, past the Clinch and French Broad rivers, to the junction of the north fork of the Holston River with the Holston at Kingsport, in Sullivan County, Tenn., all usages to the contrary notwithstanding."

Congressional legislation, however, in several laws appropriating money for the improvement of the Upper Tennessee between Knoxville and Chattanooga, has given authority for extending the name at least to the former city, but as the junction of the Holston and French Broad rivers is but 4½ miles above Knoxville, this point is now generally taken as the head of the Tennessee River, and in the river and harbor act of 1890 this point appears to have been definitely fixed by the specific language of the act providing for a survey of the Tennessee River from Chattanooga to the junction of Holston and French Broad rivers.

As one of the largest of the forty-three or more tributaries of the Mississippi River the Tennessee has always held an important place in the projects for the improvement of the navigable waterways of the country. The Muscle Shoals Canal having been opened to navigation, the Tennessee River is now navigable from its source to its mouth, a distance of 673 miles, during several months of each year, and as work is continued upon certain other less formidable obstructions the season of navigation will be correspondingly lengthened. The radical improvement of this river, so as to make navigation continuous throughout its entire length for boats of moderate draft, is by no means an impossibility.

### 1. ABOVE CHATTANOOGA (188 MILES).

This section of the river is navigable during medium and high stages, which usually prevail through the winter and spring months, and occasionally at other seasons during the occurrence of so-called rain tides.

The navigation consists of steamboats carrying freight and passengers, flatboats bringing products from the upper tributaries, and rafts of logs and lumber, also brought from the tributaries, the latter constituting the major part of the commerce of the Upper Tennessee River.

In 1830 Col. S. H. Long, U. S. Topographical Engineers, made a careful examination of the Holston and Tennessee rivers between Kingsport, Tenn., and the Alabama State line. His report, published as House Ex. Doc. No. 167, Forty-third Congress, second session, gives a detailed description of every obstruction to navigation at that time and plans and estimates for their improvement. In 1871 an examination was made between Knoxville and Chattanooga by Capt. L. Cooper Overman, Corps of Engineers, under the direction of Maj. Walter McFarland, Corps of Engineers. (See Reports of Chief of Engineers, 1871, pp. 502–507, and 1872, pp. 488–494.) The obstructions to navigation, as described in these reports, were "low-water obstructions," consisting of bars, either rock or gravel, extending across the river, with lengths varying from 60 feet to 2 miles, the depth of water over these bars varying from 10 to 30 inches at extreme low water, and the current varying from 2½ to 6 miles per hour.

The bed and banks of the river are of such character as to make any improvements practically permanent, with the exception of the removal from time to time of such drift or snags as may be brought down by the annual floods.

In 1832 the State of Tennessee undertook the improvement of certain points above Chattanooga by removal of rock and construction of wing dams, but there is no record of the work done and it did not prove of lasting value.

In 1850 Congress appropriated $50,000 for the improvement of this portion of the river, and the money appropriated was expended under the direction of Col. J. C. McClellan, Topographical Engineers, U. S. Army. Some of the dams built under this appropriation are still in existence, though generally covered up by the more extensive work of recent improvements.

The present project of improvement is based upon the examination of 1871, and provides for the removing of snags and drift, and for deepening the channel at the worst obstructions by blasting and dredging or by scouring the bars by the aid of wing dams to an extent that will secure a channel 3 feet in depth at average low water, and at an estimated cost of $340,000. The estimate of 1871 was increased in 1874, 1877, 1884, and 1891 for the reasons stated in the reports of those years.

Under the provisions of the river and harbor act of September 19, 1890, a "careful and comprehensive survey" of the Tennessee River above Chattanooga was made "with a view of ascertaining to what extent the navigation of the river is capable of improvement and the cost of the same and the preparation of suitable plans therefor." This survey was begun in May, 1891, and completed during the present fiscal year. The report, with estimate and plans, was submitted to the Secretary of War in February, 1893, and forms House Ex. Doc. No. 252, Fifty-second Congress, second session. The plan of improvement proposed is the same as that now in progress, as above stated—that is, to obtain a 3-foot low-water navigable channel between Chattanooga and the mouth of the French Broad River, at an additional estimated cost of $650,000, the balance of the former estimates, $44,000, being wholly inadequate for the purpose, as can be readily seen by reference to the survey reports, forming part of this Annual Report, upon the improvement of the Tennessee River. If the present project—that of securing 3-foot low-water navigation—is to be carried out, a revision of the estimate of cost must of necessity be made in accordance with the data given in the survey report of February 23, 1893, submitted to Congress for its consideration.

Sixteen appropriations have been made by Congress for this work, aggregating the sum of $296,000, viz.:

| Act of— | | Act of— | |
|---|---|---|---|
| July 11, 1870 | $35,000 | March 3, 1881 | $7,000 |
| June 10, 1872 | 25,000 | August 2, 1882 | 7,000 |
| March 3, 1873 | 25,000 | July 5, 1884 | 3,000 |
| June 23, 1874 | 25,000 | August 5, 1886 | 7,500 |
| March 3, 1875 | 40,000 | August 11, 1888 | 15,000 |
| August 14, 1876 | 15,000 | September 19, 1890 | 30,000 |
| June 18, 1878 | 15,000 | July 13, 1892 | 25,000 |
| March 3, 1879 | 11,500 | | |
| June 14, 1880 | 10,000 | Total appropriated | 296,000 |

The amount expended, including outstanding indebtedness, to June 30, 1892, was $269,303.10. This expenditure has resulted in giving a lengthened season of navigation and an improved channel at 29 of the 43 obstructions enumerated by Colonel Long in his report of an examination made in 1830. Operations have consisted generally of excavating rock and gravel from the channel and building stone dams where necessary to give increased depth over reefs and shoals. It is reported that the work done at White Creek Shoals was rendered specially advantageous by causing the removal of the sand bar to deep water, "and it is believed that it is not likely to reform for many years in the navigable channel." The channel and reefs at Soddy Shoals were examined and the work of drilling and blasting the rocky ledges forming the dangerous reefs of that obstruction was begun.

The field work of the Tennessee River from Chattanooga to the mouth of the French Broad River, provided for by act of September 19, 1890, was completed and the office work in the preparation of maps, plans, and estimates was well advanced.

During the present fiscal year the maps, estimates, plans, etc., pertaining to the survey of the Tennessee River above Chattanooga were completed and report rendered February 23, 1893.

There being no probability that the steamer *McPherson* could be used to advantage in the shoal waters of the upper Tennessee and its tributaries, authority was obtained to sell her for $3,300 to Capt. Geo. W. Goethals, Corps of Engineers, for use upon the works in his charge. The *McPherson* was sold and the proceeds of sale duly credited to the works upon the Tennessee ($2,400) and the French Broad ($900) rivers. In place of the *McPherson* a small steamboat, the *Stephen H. Long*, of light draft (about 14 inches), was built, at a cost of nearly $4,000, and has proved well adapted to the purpose of navigating the shallow channels of the Tennessee and French Broad rivers. Four large barges were also built for use upon the work, at an aggregate cost of $1,555.

At Soddy Shoals, 23 miles above Chattanooga, work was carried on for about four months, from the middle of August to the middle of December; but by reason of heavy rains and consequent high water only about three months' actual work was accomplished. About 635 cubic yards of solid rock and 15 cubic yards of loose rock, 145 snags, and 267 overhanging trees were removed from channel, 4,052 cubic yards of dam built, and 1,496 cubic yards of old dam calked. The cost per cubic yard of removing the rock in place was about $3.40; of loose rock, 95 cents; building riprap dams, $1; calking old dams, 93½ cents. The average cost of removing snags was about $1.75 each, and cutting of trees 55 cents each.

From December to April the fleet was at moorings in Chattanooga as a measure of economy and safety.

On April 18 the fleet was towed up to Caney Creek Shoals, 99 miles above Chattanooga. Quarry and camp privileges were secured, quarry opened, 1,152 cubic yards of quarry stripped, 985 cubic yards of stone quarried for dams, and fourteen overhanging trees cut down. High water has greatly hindered the work on dams and in channel. The report of Mr. R. R. Thacher, superintendent in charge of the works of improvement on the upper Tennessee and its tributaries, is hereto appended.

The amount expended, including outstanding indebtedness, during the fiscal year ending June 30, 1893, was $22,786.98, divided as follows: General improvement, $21,467.65; survey above Chattanooga, $1,319.33.

| | |
|---|---|
| The estimates for improving Tennessee River above Chattanooga amount to | $340,000.00 |
| Amount appropriated | 296,000.00 |
| Amount (part) received, sale of steamer *McPherson* | 2,400.00 |
| Amount expended, including outstanding indebtedness | 291,944.05 |

*Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $1,842.93 |
| Received from sale of steamer *McPherson* | 2,400.00 |
| Amount appropriated by act approved July 13, 1892 | 25,000.00 |
| | 29,242.93 |
| June 30, 1893, amount expended during fiscal year | 20,675.35 |
| July 1, 1893, balance unexpended | 8,567.58 |
| July 1, 1893, outstanding liabilities | 2,111.63 |
| July 1, 1893, balance available | 6,455.95 |
| Amount (estimated) required for completion of existing project | 44,000.00 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895 | 44,000.00 |
| Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893. | |

## REPORT OF LIEUT. COL. HENRY M. ROBERT, CORPS OF ENGINEERS, UPON SURVEY OF TENNESSEE RIVER FROM CHATTANOOGA TO THE JUNCTION OF HOLSTON AND FRENCH BROAD RIVERS, TENNESSEE.

[Printed in House Ex. Doc. No. 252, Fifty-second Congress, second session.]

NASHVILLE, TENN., *February 23, 1893.*

GENERAL: I have the honor to forward herewith the report of Capt. John Biddle, U. S. Corps of Engineers, on the survey of the Tennessee River "from Chattanooga to the junction of the Holston and French Broad rivers," about 4 miles above Knoxville, Tenn., the entire distance covered by the survey being about 188 miles. The report is accompanied by 109 detailed maps,* nearly 3 feet by 4 feet, and 2 index maps.*

The river and harbor act of September 19, 1890, appropriated $15,000 for making "a careful and comprehensive survey of said river, from Chattanooga to the junction of the Holston and French Broad rivers, with a view of ascertaining to what extent the navigation of the river is capable of improvement, and the cost of the same, and the preparation of suitable plans therefor."

The field party was organized May 10, 1891, and the field work completed October 31, 1891, while the work on the maps and report has taken to the present time. Lieut. Col. John W. Barlow, Corps of

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* Not printed.

Engineers, was in charge of the district until October 23, 1891, only a few days before the completion of the field work.

The Tennessee River, from its head to Chattanooga, about 188 miles, has usually a limestone bed, covered with a thin layer of gravel and sometimes sand. The fall in this distance is 179.7 feet, or an average of about 1 foot per mile. There are thirty-four shoals with less than 2 feet at low water, the portion with less than 2 feet averaging nearly 800 feet in length at each shoal; and fifty-four shoals with less than 3 feet for an average length of nearly 2,500 feet on each shoal. As we go to still greater depths the amount of improvement to be done increases rapidly to get 4 feet, requiring the improvement of at least sixty bars for an average length of about 4,000 feet each.

Captain Biddle is of opinion that the river is susceptible of improvement to 5 feet depth, but thinks the cost will be $3,000,000, against $600,000 for a 3-foot channel, and that the advantage to commerce would not at present justify the additional expense.

I concur in the opinion of Captain Biddle that a 3-foot low-water navigation should be first secured, and then it will be time to consider the question of further improvement. To obtain this in twenty years it will be necessary to get an appropriation of $60,000 from every Congress during this period. The Tennessee is so dependent upon its great tributaries that this upper portion will not require more than a 3-foot channel at low water until after they have been improved.

The estimates for work of this kind must necessarily be very rough. Col. S. H. Long aimed at getting 2 feet depth at an estimated cost of about $10,500. Maj. W. McFarland estimated for a 3-foot channel $175,000 in addition to the $50,000 appropriated in 1852. This estimate of Major McFarland's was increased in 1877 to $225,000, and in 1884 to $300,000, and in 1891 this was increased to $340,000, of which $296,000 have been already appropriated. The $600,000 estimated as the cost of now obtaining a 3-foot channel is in addition to all amounts heretofore appropriated, and, in my opinion, is a fairly approximate estimate, considering the many uncertain elements involved, and not allowing for contingencies of engineering. The experience of the past has shown that a few inches change in the water level may add 50 or even 100 per cent to the cost of such work. The estimate is based on shallow-rock excavations, costing $4; and stone dams and shore protection, $2 per cubic yard, and the removal of gravel, $1 per foot of channel, which agrees closely with experience on the Upper Tennessee River.

The plan of improvement proposed is the same as that now in progress, which has proved very satisfactory. Usually the waterway is reduced in width at low water by the construction of a cross dam from one bank, with its crest about 2 feet above low water. If there is an island or bar above low water the dam connects the shore with the island or bar. Otherwise, a longitudinal dam runs downstream from the end of the cross dam, if the river is very wide, which is usually the case at the shoals. Check dams are then built from one side or the other of this narrowed channel, these check dams being put in successively as they may be required to give a uniform gentle slope to the water's surface at low water. Rocky reefs and bowlders as well as gravel are removed from the channel, the latter sometimes with a plow and a scraper. The dams used extend about 2 feet above low water, with side slopes of 1 on 1, and a width of 8 feet for longitudinal and 10 feet for cross dams. To make such improvements economically requires a man of good judgment to be on the ground while the work is in progress to see the effect of each dam as built. The work must generally be done while the river is but little above its low stage, and therefore a large fleet of boats must be kept for this service so as to press the work rapidly during the most favorable season.

In carrying on this work I do not think it best to aim at getting 3 feet at once at every shoal improved, though blasting wherever done should always be carried to the full depth required for a 3-foot channel, as the expense would be but little more than for a foot less. Judgment should be used in improving the worst shoals and the worst parts of these, so as to help navigation as quickly as possible.

In conclusion, I would say that it is possible that the Tennessee River, from the Junction of the Holston and French Broad rivers, is capable of being made navigable to a depth of 5 feet at low water without the use of locks and dams, but the cost would be very great. As the river should be first improved to a depth of 3 feet, and as this will in all probability take twenty years, it is better to wait until then to estimate the cost of further improvement. Captain Biddle roughly estimates that a 5-foot channel can be obtained for about $3,000,000.

A 3-foot channel is greatly needed, and can be obtained at a cost which is fully justified by the present and future demands of commerce. I would estimate the cost of a 3-foot channel as follows:

*Estimate.*

| | |
|---|---|
| 225,000 cubic yards dams, at $2 | $450,000 |
| 10,000 cubic yards riprap, at $2 | 20,000 |
| 20,000 cubic yards rock excavation, at $4 | 80,000 |
| 20,000 linear feet dredging, at $1 | 20,000 |
| Contingencies | 80,000 |
| Total | 650,000 |

This estimate is based upon the work being pressed with vigor. Besides, the increased cost due to small appropriations, extending the work over a great many years, involves an increased cost due to the maintenance and repair of the dams during the progress of the work. If we allow only 1½ per cent per annum of the cost of the improvement for repairs and maintenance, it will be readily seen that something like $10,000 will be required annually for this purpose after the completion of the work. When the work is two-thirds completed the annual charge for maintenance and repairs would be $6,500, or for the next ten years it would amount to $65,000, even if no additional work were done.

Very respectfully, your obedient servant,

HENRY M. ROBERT,
*Lieut. Col. of Engineers.*

Brig. Gen. THOMAS L. CASEY,
*Chief of Engineers, U. S. A.*

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### REPORT OF CAPT. JOHN BIDDLE, CORPS OF ENGINEERS.

NASHVILLE, TENN., *January 28, 1893.*

COLONEL: I have the honor to submit the following report, with accompanying maps, of the survey of the Tennessee River from Chattanooga to junction of Holston and French Broad rivers made under the act of Congress dated September 19, 1890, as follows:

"Improving Tennessee River above Chattanooga, Tenn.: Continuing improvement, $30,000, of which $15,000, or so much thereof as may be necessary, shall be used in making a careful and comprehensive survey of said river from Chattanooga to the junction of the Holston and French Broad rivers, with a view of ascertaining to what extent the navigation of the river is capable of improvement and the cost of the same and the preparation of suitable plans therefor."

The report is divided into the following heads:

I. Field and office work.
II. General description of river.
III. Detailed description of river.
IV. Project for improvement.
V. Tables:
  Table 1. Shoals and depths.
  Table 2. Distances.
  Table 3. Elevations.
  Table 4. High water.
  Table 5. Discharge measurements.
  Table 6. Current measurements.
  Table 7. Description of bench marks.
  Table 8. List of maps.

## I.—FIELD AND OFFICE WORK.

### FIELD WORK.

The general scope of the field work was as follows: To determine the length, width, and general topography of the river; to determine the level of the water surface at the time of survey, and as closely as possible the low-water surface, particularly the fall at shoals; to sound the river thoroughly, locating all obstructions and ascertaining the character of the bottom; to obtain data showing the stages of high water, the effect of improvements, the changes in the bed, etc.; to determine the discharge; to establish a system of bench marks for future reference; to collect any information pertaining to the improvement of the river. The topography of the banks was considered subordinate.

*Party.*—The party was organized mostly at Chattanooga on May 10, 1891, and then proceeded on the U. S. S. *McPherson* up the river to point of beginning of survey. Three quarter boats, two for use on survey and one for river work, were taken in tow. The trip took eight days, considerable delay being experienced in passing the various rapids, due to the inability of the steamer to stem them with her tow and the consequent necessity of warping through. At almost every rapid from White Creek Shoals to head of survey a rope had to be laid. As the steamboat had no steam capstan warping was very slow work.

The party was employed at the capstan, in general steamboat work, also in making stadia rods, fitting cross hairs in transits, and making general preparations.

At Knoxville the organization was completed, with the exception of a few changes made later. The party consisted of J. L. Van Ornum, assistant engineer; S. W. Frescoln, assistant engineer; John Henson, pilot; L. D. Hollingsworth, H. G. Crowder, and P. D. Cunningham, instrument men; B. F. Cheatham, Thomas Evans, W. H. Gowen, J. A. Isbell, W. H. D. Moore, C. R. Toms, Charles Trabue, Edw. Trabue, Allen Van Ornum, rodmen; one cook, one cabin boy, and nine to eleven laborers.

The means of transportation and for quarters were two quarter boats floating with the current, and six to eight rowboats and canoes.

Work in the field was begun on May 21, 1891. The party was disbanded October 1, excepting a small force that was kept at work until October 31.

*Plan of work.*—All measurements were taken by the stadia. The original readings of the wires and their permanency were tested from time to time by a steel tape.

The transit work was done by two parties, one working on either side of the river, and connecting with each other at points averaging not over 2 miles apart. Angles were calculated to the true north. Azimuths were determined by observations on Polaris about every 15 or 20 miles, and the magnetic bearing of each course was read as a check. The line run was plotted day by day to detect errors in time for correction.

Leveling was done by two parties, working as far as possible on opposite sides of the river, connecting at frequent intervals, taking water surfaces when necessary to determine slope of river. Whenever any serious discrepancy in the two lines showed itself the lines were rerun.

Soundings were made and located by a separate party. The method was that of polar coördinates. A transit was placed at a convenient point, its backsight taken on a second point. A stadia was held in the sounding boat, and the angle and distance read from the transit at about every third or fourth sounding. Signals were arranged with flags between the observer and the boat. The position of the transit and backsight were located by the transit parties. The soundings, at from about 10 to 25 feet apart, were made with a pole up to about 12 feet deep, and then with a lead line.

Cross lines were sounded the whole length of river at intervals of from 75 to 600 feet according to depth. In very shallow places additional lines up and down stream were sounded. The channel was likewise located and sounded. The total number of soundings was about 170,000.

The method of reducing soundings to low water was as follows: Gauges were read at six points along the river continuously throughout the season. On four of these low-water mark had been established. A daily gauge was kept at the boat. At the head and foot of each shoal and at intermediate places in long stretches stakes were driven showing stage of water at time of survey. At the lowest water of the year—about 1.2 feet at Chattanooga and 0.7 foot at Knoxville—the fall from time of survey was read. Knowing the fall from this low state to absolute low water at four points, the others were reduced proportionately. In a stream like the Tennessee, where the bed is almost permanent, this method could be pursued with sufficient accuracy. The final stage of observation was so low that the dams showed their full effect.

As the transit parties proceeded more rapidly than the sounding party, extra work, such as boring for ascertaining bottom in shoal places, establishing bench marks, soundings in back channels, etc., was done by the former.

Borings were made with a round, pointed steel rod, driven by a sledge. They had for object determining the distance of solid rock below the surface of bed. Bench marks were usually bolts 6 inches long, driven to about 1 inch of head in a hole drilled in the rock. The lower end of the bolt was split and a wedge inserted. Striking on the head of bolt forced the flanges firmly against the sides of the hole. Cross marks cut in the rock and lettering with paint served further to locate the bench marks. When no rock ledges were near at hand the bench marks were stones sunk in the ground.

Current measurements for discharge were taken at the lowest stage for the year 1891, at points below Knoxville and Loudon on the Tennessee River, and at points on the Clinch and Hiwassee rivers about a mile above the mouths. In 1892 the discharge was measured at Soddy Shoals. The instrument used was a Buff & Berger electric meter. It was rated by rowing over a laid-off course on a piece of still water. Additional measurements of discharge were obtained from other observers. Current measurements for velocity of rapids were taken at several points, as shown in appended table.

*Progress.*—The progress in that part of the river above the mouth of the Clinch River was much slower than below that point. On account of the greater narrowness and crookedness of the boat channel, its less depth, and the greater variation of level of river due to rises while work was being carried on, it was necessary to more thoroughly locate the bottom in the upper section than in the lower, and the water being generally higher the work was more difficult. More loss of time through bad weather was also experienced in the earlier part of the survey than subsequently, and the more thorough organization and greater experience of the party facilitated work in the latter section.

From the point of beginning to mouth of Clinch River, a distance of 84.3 miles, it took 87 days, or an average of a little less than a mile per day, including Sundays, rainy days, etc. From mouth of Clinch to Chattanooga, a distance of 103.8 miles, it took 46 days, or 2¼ miles per day.

*Accuracy of stadia work.*—This can be judged in this case only by comparing the two transit lines, as the geodetic position of Chattanooga has not been determined with sufficient exactness to be of value. The soundings being located by the transit also served as a general check. The two transit lines were run independently by separate parties. The lines were connected about every 2 miles.

The comparison was made by adding the latitudes and the departures of each line from the head of survey to mouth of Clinch River, from the mouth of Clinch to Chattanooga, and from the head of survey to Chattanooga. The difference of these results divided by the sums gives the rate of error, as follows:

*Error of closing.*

| | Latitude. | Departure. |
|---|---|---|
| From head of survey to mouth of Clinch | 1-2300 | 1-4500 |
| From mouth of Clinch to Chattanooga | 1-1700 | 1-1000 |
| From head of survey to Chattanooga | 1-5300 | 1-1500 |

The average error of closing of the small traverses formed each time the lines were connected, as follows:

*Average error of closing small traverses.*

| | Latitude. | Departure. |
|---|---|---|
| From head of survey to Clinch River | 1-460 | 1-554 |
| From Clinch River to Chattanooga | 1-230 | 1-335 |
| From head of survey to Chattanooga | 1-270 | 1-380 |

The degree of accuracy obtained in the section above the mouth of the Clinch River is greater than that in the section below on account of the difference of method pursued. Above this point each transit party remained as much as possible on its own side of the river and took comparatively short readings. Below the Clinch, on account of the fields of very high and thick corn and the heavy fringe of timber, it was impracticable usually to proceed along the banks, and therefore it became necessary to take zigzag views across the river, these often calling for very long sights. The upper part of the river thus more nearly represents ordinary accuracy obtainable with stadia.

*Accuracy of level.*—In the early part of the survey the instruments used were old and parts of the lines had to be several times rerun. These instruments were replaced. In places on the lower river long sights were sometimes necessary. In such cases it was always endeavored to take equal sights. The levels were compared daily and the readings brought together. A line was afterwards run connecting Chattanooga and Knoxville along the line of the railroad, and then prolonged to head of survey, using all the accuracy obtainable by ordinary leveling.

Comparing this last line with the average of the two level lines along the river, it is found that the difference between them from Chattanooga to Loudon is 0.3 foot, and from Chattanooga to mouth of French Broad River, 1.3 feet.

Taking the mean as the true elevation, thus giving to the line run along the railroad a weight equal to the average of the other two, we have a total difference between the mean and the extremes of 0.65 foot. Since the distance is 188 miles, the difference per mile is 0.0035 foot, and per foot, 0.0000007 foot. Comparison was also made with the levels of the railroads centering at Knoxville and Chattanooga. The general accordance was good.

### OFFICE WORK.

The office force consisted of one regular draftsman, not employed continuously, and from one to three assistant draftsmen. The time taken was about fourteen months.

There are, pertaining to the survey, 109 regular maps and two index maps. The size of the border is 3′ 10″ by 2′ 10″. Tracings were made of all the maps.

The scale is usually 1:2000, except in long pools, where it is 1:4000. In shoal places profiles of the bottom, showing also stage of water at time of survey and the low-water surface, as calculated, are drawn on the maps. The horizontal scale of profiles is 1:4000; the vertical, 1:40.

Soundings are entered in sufficient number to show all known variations in the bottom.

The topography was put on the maps with rollers devised by Mr. J. A. Ockerson, C. E., and names with a lettering device also designed by him. The titles, legend, arrows, stations, etc., were printed with electrotype plates. Rubber stamps were tried without success. It was difficult to make the pressure even, and the stamp soon wore out. Wooden plates were also tried, but proved inferior to the electrotypes. The latter worked well. Frames were constructed to hold the plates and allow an even and hard pressure. The rollers were satisfactory, especially on large surfaces. For a narrow band, such as the border of willows which lines the banks almost the whole length of the river, it was found best to use a short piece of electrotype. This gave a better defined border than a roller.

The lettering device should be larger, so as to hold more letters; otherwise it was satisfactory.

After experience with the apparatus, one draftsman averaged three and one-half to four hours per map when there were a number to work on. This included putting in the titles, legends, etc., the topography, the lettering, and final retouching.

The paper should be smooth; eggshell paper is not suitable. Tracing linen works well, but takes long to absorb the ink so as to be dry. The method of using the rollers is to place transparent paper on the map, cut out with a knife the parts where the topography is to be printed, and then press over with the roller. The paper to be cut should be thin and have some stiffness. To cover names, houses, creeks, etc., Mr. Ockerson recommends the use of starch. It was found in this office that a little strip of paper answered the purpose better.

The ink should dry readily; German printing ink answered well on the paper. It takes a couple of weeks to dry thoroughly in this climate. It can be thinned with coal oil or made to dry better with Japan drier. On tracing linen it does not dry readily. Insurance-policy black ink, although a cheaper grade of ink, dries more rapidly and has been used exclusively on the tracings.

Without the devices it would have been impossible to complete the maps with the funds available for the survey.

The plane of reference for the levels was taken at the zero of the Chattanooga gauge, assumed to be 630.64 feet. The history of that elevation is, as far as I can ascertain, as follows: In 1871 Mr. F. T. Hampton, assistant engineer, under Maj. W. McFarland, Corps of Engineers, established a bench mark on the coping of the old First National Bank building, on the southwest corner of Sixth and Market streets, Chattanooga. This place was indicated by a small cut about 1¼ by one-half inch on the coping of the north side. The elevation was assumed at 100.

In 1875 Major McFarland had a gauge placed in the river showing high and low water, and referred to this bench mark. About 1876 the height above sea level was determined by barometrical observations and comparison with railroad surveys, and the gauge was turned over to the Signal Department by Maj. W. R. King, Corps of Engineers. In 1881, the gauge having become displaced, it was relocated as before by Mr. Robert Hooke, now city engineer of Chattanooga.

Later the elevation above sea level was again determined under Mr. B. L. Goulding, of the Signal Service, assisted by the United States Engineer Office and by Mr. F. E. Fairleigh, city engineer of Chattanooga. This elevation was connected with the railroad surveys of the East Tennessee, Virginia and Georgia and of the Western and Atlantic railroads. Later a steel gauge replaced the wooden one at the bluff above the county bridge, as it exists to-day, and in the winter of 1891-'92 an extra gauge was placed on a pier of the bridge. The elevations above sea level differ but slightly from each other, and as finally determined are:

| | Feet. |
|---|---|
| Elevation of zero of gauge | 630.64 |
| Elevation of bench mark at Sixth and Market streets | 684.02 |

*Cost.*—The cost of the survey was $15,000, of which about $11,000 were spent on field work and $4,000 on office work.

## II.—GENERAL DESCRIPTION OF RIVER.

The Tennessee River is formed by the junction of the Holston and French Broad rivers, about 4½ miles above Knoxville, Tenn. It flows southwest 51 miles to the mouth of the Little Tennessee River, its first considerable tributary, receiving in that distance only one tributary other than creeks, the Little River.

From the Little Tennessee River it flows west-northwest to the mouth of the Clinch River, the second large tributary, 84 miles from head, and then turning to the left flows south-southwest to Chattanooga, receiving, 150 miles from head, from the southeast, the Hiwassee River. The total length above Chattanooga is 188 miles.

All these streams that form the Tennessee are similar in kind and not very different in size. They rise in the mountains of Virginia and North Carolina and flow down over rocky, winding beds to their mouths. They are, except the Holston, navigable at ordinary stages for some distance above their mouths, and the French Broad and Hiwassee have regular steamboat service.

The Tennessee River, above Chattanooga, passes through or forms the boundary of the following counties of Tennessee: Knox, Blount, Loudon, Roane, Rhea, Meigs, James, and Hamilton. From the geological map of that State, 1888, the principal formations of these counties are:

Knox County, limestone, with excellent marble; Blount County, limestone, marble, sandstone, iron, copper; Loudon County, limestone, marble; Roane County, limestone, sandstone, iron, coal; Rhea County, limestone, sandstone, iron, coal; Meigs County, limestone, iron; James County, limestone, sandstone, shales, iron; Hamilton County, limestone, sandstone, coal, iron.

From the head of the river to the mouth of the Little Tennessee, and from the mouth of the Clinch to Chattanooga, the river flows in the direction of the upturned geological formations. Between the Little Tennessee and the Clinch it cuts through these formations. No difference was distinguished in the river as far as navigation is concerned in the two parts. The bed of the river is usually limestone rock covered with a thin layer of gravel and occasionally sand. Good stone for dams can be obtained near any point. While all the country has excellent mineral resources, agriculture is still the main dependence of the inhabitants. The bottom lands, and especially the islands, are very fertile. Good springs are frequent. The river water is good, but it is not very palatable in hot weather without ice.

The river is winding, especially in the upper part. The concave bank is usually steep and high, often of rocky bluffs; the projecting points are low and arable. The banks are protected almost continuously by a willow or timber growth, and there is but little cutting or washing away. The islands seem generally to be increasing at the upper end. They are, as a rule, covered by a growth of timber at the head and foot. Side channels show a tendency to close up. In certain places bars are forming, but the action is slow. Dams are, as a rule, tightening by material carried by the current. Altogether the bed of the river is exceptionally permanent and all improvements of lasting value. The channel has changed but little in the last fifteen years.

The cities along the river are Chattanooga and Knoxville. The smaller places are Louisville, Concord, Lenoir City, Loudon, and Kingston. Lenoir City is a new place started by a company. From the Clinch to Chattanooga there are no settlements of any size along the river, though several towns are found a few miles back. In general the country is not thickly settled. The land is quite thoroughly cultivated.

The season of navigation for the Tennessee River usually lasts most of the year. During the period of deep water larger boats are used and more frequent trips are made. The average stage of water for Chattanooga for eighteen years, from 1874 to 1891, inclusive, is as follows:

| Above— | Days. | Above— | Days. |
|---|---|---|---|
| 40 feet | 2 | 4 feet | 242 |
| 30 feet | 7 | 3 feet | 282 |
| 20 feet | 19 | 2 feet | 322 |
| 10 feet | 68 | 1 foot | 356 |
| 5 feet | 197 | 0 foot | 365 |

These stages of water are not continuous, but represent at times sudden rises and falls, so that the number of days of navigation corresponding to a certain stage would be less than that given. Low water occurs usually in the autumn, and high water from January to April, though rises may come at any time. The highest average for ten years was on January 22, with 17.5 feet, and the lowest on October 2, with 1.4 feet. The highest water recorded was on March 11, 1867, 58 feet; and the 0 was reached for several days in September, 1881 and 1883. The river at Chattanooga is generally higher and keeps the rises longer than above, as at Knoxville. The data for the latter point are not complete, as the United States Signal Service takes observations only during high water. An average of two years, 1875 and 1876, at Knoxville gives:

| Above— | Days. | Above— | Days. |
|---|---|---|---|
| 40 feet | 1 | 4 feet | 103 |
| 30 feet | 2 | 3 feet | 158 |
| 20 feet | 5 | 2 feet | 246 |
| 15 feet | 10 | 1 foot | 338 |
| 10 feet | 24 | 0 foot | 365 |
| 5 feet | 71 | | |

While these data do not cover a long enough time to give a good average, yet they will represent fairly well a comparison between the two points, Chattanooga and Knoxville, and show the greater duration of higher stages at the former place. The relative possibilities of navigation of the lower river as compared with the upper are therefore better than would appear from the appended table of depths at low water. Moreover it will be noticed that above the Clinch River the shoals are very much shorter and steeper, with deep pools between, while below that point the shoals are at times a number of miles long, with fairly good water all the way, but without deep places. Generally speaking, the Tennessee River above the Clinch is not so suitable for navigation as below.

The general record does not indicate that on this river as yet the high-water stages are increasing and the low diminishing, which is liable to be the case as the country is cultivated.

*Former surveys and examinations.*—The first recorded examination was made by Bvt. Lieut. Col. S. H. Long, Topographical Engineers, in 1830. The method of examination is not stated, but the report and map are exceedingly accurate. Based on this examination, works of improvement were undertaken. They were not of much importance or of lasting value, and we have no complete record of them.

In 1871 an examination was made by Capt. L. C. Overman, Corps of Engineers, and the present plan of improvement is based on his report, which was submitted by Maj. W. McFarland, Corps of Engineers, in 1872.

In 1875 surveys of the majority of the shoals between Knoxville and Loudon were made and platted, and in the last five years individual shoals have in a few cases been surveyed before making improvements.

*System of improvement.*—The depth sought for by Colonel Long was 2 feet at low water: to-day, 3 feet is the depth desired. The general system followed from the earliest improvement has been to clear away snags, close up side chutes, narrow and confine the channel by dams, cut through reefs, remove prominent rocks, and at times to clear away gravel bars. For the latter the force of the confined current has usually been considered sufficient. The general effect has been good. The navigation has been greatly improved. The depths desired have, however, not been obtained in a number of cases, as is shown by appended table of depths. The works are of lasting value. Bars are forming at the foot of longitudinal training walls and around some of the dams, but this formation is slow.

*Estimates and expenditures.*—The estimate of Colonel Long was about $10,500, of course a very small and insufficient one. Some appropriations were made by the State and work carried on, but there is no record of the work, and it did not prove of lasting value. The first appropriation by the National Government was made in 1852 of $50,000; this was expended about 1853 by Col. J. McClellan, topographical engineer. Since 1872 a regular system of estimates and appropriations has been carried out.

The first estimate was in 1871, $175,000. It was increased first to $225,000 in 1877, then in 1884 to $300,000, and in 1891 to $340,000. Of this amount $296,000 have been appropriated and expended. This does not include the $50,000 appropriated in 1852.

The appended table of depths shows how insufficient even the greatest of these estimates has proven. This is due, in part, to the uncertainty of regular and adequate appropriations.

*Commerce.*—The steamboat commerce of the river consists in bringing the farmer's produce to market, in supplying him with merchandise, in taking iron ore and coal from the mines to various points, bringing sand for building, etc. The steamboat lines running regularly, when water allows, are between Chattanooga and Kingston, including Eureka mines; Chattanooga and the Hiwassee River; Kingston and Loudon, and a strip of 5 miles from the mouth of the French Broad to Knoxville. The Kingston and Loudon line, called the Emory River Transportation Company, connects during a part of the year with Harriman, on the Emory River.

The commerce varies in quantity from year to year, increasing in some articles and decreasing in others, but in all not showing any decided increase or decrease in the last ten or twelve years. Saw logs are brought down in large quantities from all the tributaries. These are taken to various mills along the line. A good deal of stone and sand is flatboated from the mouth of the French Broad and other points to Knoxville, marble from near Louisville to Concord, and farmers take down products for short distances to the various towns and stores scattered along the banks.

Generally speaking there is no commerce of any importance between Knoxville and Lenoir City, a distance of 46 miles. The navigation of this part of the river is difficult, but during much of the year it is possible. Steamboat lines have at times been started, but without success. Only occasional trips are made. This is due to the railroad that skirts along the right bank from Knoxville to Loudon. A new railroad has recently been built along the left bank down to about the same point, so that a local commerce over that part of the river does not seem probable at present. While, therefore, this part should be considered in the general improvement of the Tennessee River, yet it is believed that it is the last that need be undertaken.

The total commerce for year ending June 30, 1891, carried on or in part on the Tennessee River above Chattanooga, was 169,144 tons and 2,716 passengers. This does not include a large but uncertain amount of stone, sand, and other materials carried in small boats and barges.

## III.—DETAILED DESCRIPTION OF RIVER.

The depths given refer to the channel.

From the junction of the French Broad and Holston rivers to Goose Neck Shoal, distance 6,000 feet, the river is deep, reaching in one place a depth of 50 feet.

Goose Neck Shoal lies at the head of Dickinson Island. It is formed by a stony, gravelly bar extending from the island across the river, with a fall of 0.9 foot in 600 feet, and a minimum channel depth of 4.3 feet. The gravel is of round stones up to 8 or 10 inches in diameter. The bar seems to be slowly enlarging from the islands. Solid rock is found from 2 to 3 feet below bottom. There are no improvements.

From Goose Neck Shoal to McNutt Shoal, 3,600 feet, the water is from 4.5 to 15 feet deep, but very reefy. There are no special difficulties of navigation, however.

McNutt Shoal is formed by a series of reefs, partly covered with gravel, alternating in deep places and ridges. Fall 0.7 foot in 1,500 feet. Least depth 1.9 feet. The channel is very reefy, but this is not considered a very serious obstruction. There are no improvements.

From McNutt Shoal to Baker Shoal, a distance of 6,000 feet, the water is from 5 to 12 feet deep and offers good navigation.

Baker Shoal consists of a gravel bar, over which there is a minimum depth of 1.2 feet and a fall of 0.9 foot, mostly concentrated in about 300 feet. There is a small reef near left bank. The former channel ran near the right bank and was called Thompson Chute. The present channel is at the left bank. The improvements comprise the removal of about 30 cubic yards of loose rock, and the building of a dam about 460 feet long. The dam is crescent-shaped with the hollow upstream. It is loosely built, 5 or 6 feet wide, and water flows between the stones. The greatest difference of level above and below the dam is about 1 foot. This dam raises the water well but concentrates all the fall at one point. It acts satisfactorily over a very short bar, as at this place.

From Baker Shoal to Knoxville Shoals, 7,000 feet, the depth is from 9 to 15 feet.

Knoxville Shoals lie opposite Knoxville, and are formed by a series of gravel bars extending the length of several small islands or tow-heads. Reefs, large rocks, and coarse gravel show themselves at several points. There are two bridges opposite the city. The channel is to the right of the islands. There is a fall of 1.75 feet extending over 3,000 feet, of which 0.6 foot is in 450 feet near the lower bridge. The least depth is in general 2.5 feet, except at one place, where it diminishes to 1.4 feet, due to a rock ledge. The description of Colonel Long gives a depth of 18 inches, and that of Major McFarland, 1872, made after the improvements, states that 2 feet can be found everywhere. A map made about 1875, and after the improvement, gives almost exactly the same depth as at present, showing that the river does not change much. Just above the upper bridge are the remains of the piles of an old military bridge that come up to about low-water surface.

The improvements are as follows: (1) Dam from head of first island to bank; (2) Dam between islands; (3) Dam between island and pier of second bridge.

Dams Nos. 1 and 2 were built before 1871 and repaired in 1884.

Dam No. 1 is 3 or 4 feet wide, roughly built, with its crest varying from a few inches below low water to about 2 feet above, leaky, full of gaps, holding up but little water. There is about 6 inches difference of level above and below dam.

Dam No. 2 is quite tight. The front edge is 2.5 feet, the rear 3.5 feet above low water.

Dam No. 3 was built in 1884. It is a low, rough dam built between two piers of lower bridge, to about height of low water.

Effect of improvement: While the depths of the shallowest parts are not as great as stated by Colonel Long or in subsequent reports, yet as these parts of the obstructions are reefs they can not have changed. Some water is excluded from the left channel by the dam, so that more water is certainly forced down the right chute than before improvement was made. Some rocks that have been removed give decided advantage. Three or 4 inches have probably been gained. This is mostly lost before the lower part of the obstruction is reached, so that it is doubtful if this last has been much improved by the dams.

The dam at the bridge, extending one-third way across river, undoubtedly gives several extra inches under the bridge at low water.

The tendency is to deposit sand on the head of the island, and Dam No. 2 is filling up and tightening; Dam No. 1 is deteriorating.

From Knoxville Shoals to head of Looney Island, a distance of 18,300 feet, the water varies from 7 to 35 feet, and in general is over 15 feet.

Looney Shoals occur at the two islands of that name. The channel is to the left of the islands, though good water can be obtained to the right, with the exception of about 500 feet. The shoals are formed by a bar of gravel, with rock coming to the surface occasionally. The gravel is regular and fine. Rock occurs at depths of from 1 to 2¼ feet below bottom. The fall is 1 foot in 3,000 feet, a great part of which at low water is near the head of island. The least depth at two points is 2 feet, the general least depth being about 2.5 feet. The water deepens rapidly after the bar is passed, being 22 feet at foot of island. This is not a difficult shoal either as to depth or velocity of current. There are no improvements.

From foot of Looney Shoals to Wells Bar, 6,000 feet, the depth reaches 35 feet and in general is over 15 feet.

Wells Bar extends from right bank for a distance of about 1,000 feet. The bar is of gravel. The depth at the center of the river is about 2 feet, but for 300 feet out from left bank the depth is not less than 5 feet. No improvements.

From Wells Bar to Lyons Shoals, a distance of 9,000 feet, the water reaches 37 feet in depth and is mostly over 15 feet.

Lyons Shoals occur at a group of islands of that name. There were originally two principal islands and one small one below. Between the two main islands is now so filled up that they form one at low water. The main channel is to the right of the islands, but except for the dam good water is also obtainable most of the distance in left chute. The obstruction is caused by a long series of rock reefs, usually covered with gravel, and by three gravel bars. The total fall is 4 feet over a length of 5,000 feet, but mostly occurs at two points, where the fall is 1.5 feet in 600 feet and 0.6 foot in 300 feet. The least depth over the first bar is 1.5 feet, over the second 1 foot, and the third 1.2 feet. Between these points the depth varies from 3 to 5 feet. The bottom is gravelly with at places pebbles up to 6 or 8 inches in diameter. Rock is found at depths varying from 0 to 3 feet below bottom. The improvements consist of a dam about 1,750 feet long extending from left bank above the island out towards right bank. The upper part of dam is rough and loose, reaching from low water to 2 feet above. It becomes more regular towards the lower end and has a general height of from 1 to 2 feet above low water. It seems fairly tight, but allows much water to be carried over and through gaps. The dam was built before 1871 and extended and repaired in 1884. A short check dam about 100 feet long near foot of main island assists over a shallow place. It is roughly built of excavated material. In 1884 2 cubic yards of solid rock, 71 of bowlders, and 744 of gravel were removed from channel.

Effect of improvement: The survey of 1830 shows that the least depth was 18 inches; that of 1871, 20 inches. The present depths are considerably less. A map made in 1875 shows the same general location of bars and deep places, but with a greater average depth of several inches and a minimum depth of 1.8 feet. Comparing these depths it is found that the river is shoaling a little between the dam and the right bank, though as this bar is mainly rock it seems this must be due to more water escaping through the dam. At the foot of the dam, where the water spreads, a bar is forming out from the island and extending nearly across the river. At this point are the least depth and the greatest fall. This bar is due to the decrease in velocity of current below the dam causing deposit of material. A pool between the second and third obstructions exhibits about the same depths as in 1875, though slightly smaller. Bar No. 3 and a stretch of 1,000 feet below show decided shoaling. The general tendency seems to be to shoal by the gravel brought from above. The right bank is cutting badly near the creek.

From Lyons Shoals to Williams Shoals, a distance of 2,000 feet, the depth varies from 5 to 14 feet, being mostly over 10 feet.

Williams Shoals occur along and below a cluster of islands of the same name. They may be divided into two groups separated by a distance of 1,000 feet with a depth over that distance of from 4 to 7 feet. The present channel runs to the right of the islands. Between the islands there is a bar, but to the left the channel is, except for the dam, about as good as to the right. The fall is 2.7 feet in a distance of 4,000 feet. The least depth is 0.6 or 0.7 foot at one place and not over 1.2 or 1.3 feet for a great part of the length, with occasional depths of 3 feet. Survey of 1830 gives 12 to 15 inches; that of 1871, 18 inches. The bottom is mostly compact gravel. Rock comes to the surface in one or two places and in general lies below the bottom at from a few inches to nearly 3 feet.

Improvements: There is a dam from upper island to left bank and one from main island to tow head above. They were built before 1871 and repaired in 1884. Eighty cubic yards of rock were removed in 1884. The dams rise from 0 to 1.5 feet above low water and do not hold up much water. The effect of these dams is so slight that their influence on the channel has been small. The less depth now than at former times is due to a general shoaling of the right chute and is thought to be independent of the dam. Colonel Long in his report suggested the possibility that the extreme left-hand chute might be the best suited for improvement and it probably would be so to-day.

The lower shoal below the islands has a fall of 0.6 foot. It is formed by a series of bars of compact gravel with solid rock from 0 to 3 feet below. The least depth is 1.5 feet; the channel is tortuous. There are no improvements. An old wooden dam cuts off water from behind a small island near right bank but can have no effect. The river is wide here, thus accounting for the slight depth. It has probably not changed much since 1830.

For a distance of 2,000 feet below the last bar the depth does not average more than 4 feet. It is sufficiently deep for present purposes of navigation, but does not offer a settling place for gravel carried down from above. Below this for about 2,600 feet the depth reaches 9 feet, and is mostly over 5 feet, though occasionally but 4 feet.

A bar then occurs about 2,000 feet long, made of reefs somewhat covered with gravel and giving at extreme low water a depth of about 3 feet.

From this bar to Little River Dam, about 1,500 feet, the depth varies from 4.5 to 9 feet.

Little River Shoals, lying near the mouth of Little River, are formed by a series of rocky ledges extending across the river, and covered more or less with gravel. The fall is 5.3 feet in 4,200 feet, of which 4.5 occurs in 2,300 feet, and of this 2.8 in 1,000 feet. The depth over the shallowest places is 1.6 and is generally not less than 2 feet. The bottom is rock, covered especially in the lower part with a shallow bed of gravel.

The improvements consist of dams and excavation. On the left they are a dam about 900 feet long from left bank to main island, a cross dam from main island out towards channel about 800 feet long, and a training wall 450 feet long connected with the latter; on the right bank a training wall 600 feet long and a check dam 150 feet long. All but the last were built before 1871. They were repaired and the latter built in 1881. The right bank is riprapped for a considerable length. The upper dam is from 0.3 foot below to 1.8 feet above low water and allows escape of water; an opening at the head of the large island also allows water to pass. The main dam is quite regularly built and tight, averaging about 2 feet above low water. The right bank dam is regularly built. It has filled up so behind that it really at present performs the function of riprap bank protection. A ring set in a rock at the point of the dam serves for warping when necessary. The lower dam is roughly built, but serves its purpose.

Effects of improvements: Reports of 1830 give a depth of 12 or 13 inches; that of 1872 states there are 18 inches. A map of 1875 gives a minimum depth of 0.7 foot on the bar opposite the ring bolt and an average of not over 0.9 foot in the stretch above the longitudinal wall. At present the least depth is 1.5 or 1.6 feet and usually 2 feet. In the chute the map of 1875 gives from 1.2 to 2.4 feet with gravel bottom; now it is from 4 to 5.5 feet and rock bottom. It has evidently cut out. When the water just runs over the dam the current at this chute is very swift, probably the swiftest on the river. Below the training wall the sudden spread of water and diminution of current caused a bar. It was sought to be avoided by the check dam below. This dam gives water about 4 feet deep just above the lower dam, but a bar exists in prolongation of the training wall, making it difficult to enter the chute at all times, but especially when the water is very low, as the current carries on to the bar.

Below the dam to foot of island the depth is 2 to 4 feet, sufficient for navigation, but not sufficient to dispose of much material, and bars are forming at different points. The general effect of the improvement is to give about 0.8 foot more water at the critical points. The bar opposite the ringbolt and the stretches of shallow water at the lower end of the dams and below are the points that need further improvement. While not the most shallow of the shoals, this obstruction is usually considered the most difficult of the upper river and also the hardest to improve.

From foot of Little River Shoals to Post Oak Islands, about 14,500 feet, the water is at places almost 30 feet deep, and generally over 10 feet.

Post Oak Shoals occur along the island of that name, which is about 1¼ miles in length. The channel is to the left of the island. The first shoal is at head of island. It is formed by rocky reefs covered with gravel. The bottom is usually coarse, compact gravel of from 0 to 3 feet thickness over the rock. The fall is 2.8 feet in 1,500 feet, the least depth 2.3 feet. The second shoal lies at the foot of the island. The space between, 4,000 feet, is from 5 to 8 feet deep and has a fall of 1.2 feet. The bottom, especially near the left bank, is ledgy, and there are a good many snags. The lower shoal is formed by rocky ledges covered in places with gravel. The bottom is mostly solid rock and reefy near the left bank. The fall is 1.3 feet, most of which occurs in lower 1,000 feet. The depth is 2.5 feet. Reports of 1830 and 1872 give no depth over this shoal. The map of 1875 gives from 0.2 to 0.5 foot greater depths than exist at present. As, however, the points of least depths usually show rock bottom, it is not probable that these depths have decreased. The right-hand channel and the slough between the islands are filling up; this filling is of advantage to the main channel. No improvements.

From foot of Post Oak Shoals to George Bar, a distance of 7,000 feet, the water is from 5 to 10 feet deep, usually about 7 feet.

George Bar has an extreme low-water depth of 4.5 feet, usually from 5 to 6 feet. No improvements.

From George Bar to Louisville, a distance of 20,000 feet, the depth reaches 25 feet and is in general over 15, except along a stretch of about 1,500 feet near Bonds Ferry, where it is from 6 to 10 feet, and over a bar at Louisville about 800 feet long, where the least depth is about 3.3 and the average about 4 feet.

From Louisville to Prater or Low Island, 8,500 feet, the depth reaches 41 feet and is usually over 20 feet. From head of island to bar, 3,000 feet, the depth is from 6 to 10 feet.

Low or Prater Shoal is situated at about the middle point of island, and is formed by a gravel bar. The channel is in right-hand chute. The least depth is 2 feet and the fall 0.4 foot in 600 feet. The left chute is almost dry. No improvements.

From this point to Russell or Cox Shoal, a distance of 6,000 feet, the river has a depth up to 24 feet and is generally over 10 feet.

Russell Shoals lie opposite and below Cox Island, over a length of 1¼ miles, with a total fall of 4¼ feet. They may be divided into three bars of shoals.

The upper shoal lies at the head of Cox Island, the channel passing to left of same. It is formed by a gravel bar, with a least depth of 1 foot and a fall of 1.8 feet in 2,500 feet, of which 1.3 feet occurs in the last 800. The bottom is made up of gravel of varying size, with rock from 1 to 2 feet below bottom. There are no improvements. The report of 1830 gives a general depth of this shoal of from 15 to 20 inches. That of 1872 states 20 inches. Comparing with map of 1875, the contours are found substantially the same as to-day, indicating only a slight extension of the bar at the head of islands. There is an old dam behind the island, not far from the foot, built probably as a fish dam or as a ford to the island.

Between the first and second bars, a distance of 1,300 feet, the depth is from 4 to 8 feet, the bottom successively rock and gravel.

The second shoal is formed by two rocky bars 400 feet apart, giving a least depth of 2.5 feet over the bars, with 5 feet between. There seems no appreciable change since 1875.

Between the second and third bars, a distance of 2,700 feet, the depth varies from 4 to 7 feet, with a bottom successively gravel and rock.

The third obstruction is formed by a gravel bar, with extreme low depth of about 1 foot and a fall of 1.9 feet in 2,300 feet, of which 1.5 occurs in about 800 feet. The bottom is composed of gravel, with rock at 1 foot to 2 feet below. Improvements consist of a dam about 400 feet long, built in 1887. It is roughly built from 1 foot to 3 feet above low water. The least depth in 1875 was about 1 foot, so it would seem that there is not much gain. The dam does undoubtedly raise the water several inches, and it is probable that the place shoaled between 1875 and 1887, so that the exact effect of the improvement is hard to determine. When dam was built it was an acknowledged improvement. The channel is shoaling below the dam.

From Russell Dam to head of Rogers Island, a distance of 9,000 feet, the depth varies from 5 to 30 feet, being generally over 15 feet.

From head of Rogers Island to Concord Shoals, about 1,500 feet, the depth is usually over 10 feet.

Concord Shoals lie along a group of islands called Rogers Islands, opposite Concord Landing. The shoals consist of three bars, with total fall of 1.8 feet. The first occurs 1,500 feet below head of island and is formed by a narrow gravel bar, with a depth of 1.7 feet for about 50 feet, and then over 2 feet. There is scarcely any fall. The bottom is gravel, with rock 2 or 3 feet below. From the first to second obstruction, a distance of 2,500 feet, the bottom is rocky and ledgy, with a depth of from 3 to 10 feet.

The second obstruction occurs near head of small island. It is a gravel bar, with a minimum depth of 1.8 feet over a distance of 50 feet and an average depth of about 2.3. The fall is 0.3 foot in 1,000 feet. The bottom is gravel, with rocks at from 0 to 1 foot below bottom. From second to third obstruction, a distance of 3,500 feet, the depth varies from 3 to 14 feet; is usually, however, not over 5 feet. The bottom is rocky, full of reefs, making navigation difficult at low water. The fall is about 0.5 foot.

The third obstruction is a gravel bar, with depth of 2.6 feet and fall of 0.5 foot in 1,000 feet. The bottom is gravel, with rock at from 0 to 2 feet below.

From this bar to the foot of the island, 2,500 feet, the depth varies from 5 to 16 feet, usually about 8 feet. The bottom is rock, sometimes covered with gravel. No improvements have been made here. The report of 1830 speaks of a bar with 15 inches of water just below the islands. This bar no longer exists, and probably the report is incorrect.

From foot of Rogers Islands to Chota Shoals, a distance of 16,000 feet, the depth reaches 27 feet, with a general depth of over 10 feet above Taliaferro Island, 10 feet along same and 15 feet below.

Chota Shoals lie along and below a group of islands of the same name. They can be divided into two groups. The first is formed by a rocky reef. The fall is 1 foot in 2,000 feet, with a least depth of 2.4 feet. The shallowest part has a gravel bottom with rock a foot or so below. From the first to second obstruction, a distance of about 1,200 feet, the depth reaches 12 feet, and is generally about 5 or 6. The bottom is usually rock, at places covered with gravel. The second obstruction is formed by a series of rocky bars and reef extending some 4,000 feet, and with shallow water for a mile or so below. At points the rock is covered with a thin layer of gravel. The least depth in the chute is 3 feet. Just below the chute the accumulation of gravel shallows the water up to 1.2 feet in one place and 1.4 in another. The channel here is tortuous and dangerous. The total fall is 4 feet in 4,000 feet, of which 2.3 occurs in about 1,200 feet near the main dam.

The improvements are as follows: (1) A dam 1,050 feet long at upper end, closing right-hand chute behind island and forcing the water to the left bank; (2) a dam and training wall 1,850 feet long at lower bar; (3) a cross dam 700 feet long, throwing water into channel from between the two islands; and (4) a dam 250 feet long joining two of the islands. These dams were built in part before 1871 and strengthened and lengthened in 1876, 1878, 1879, 1880, and 1884. Besides the dam work, 800 cubic yards of rock excavation and bowlders and 53 of gravel were removed between 1876 and 1879.

Dam No. 1 is a very solid dam. It is built with regular faces and is heavily riprapped both above and below. It is up to 40 feet thick at the angle and usually, with the riprap, is over 20 feet. The height above low water is about 1¼ feet, and is greater near the bank. The difference of water level above and below dam at the bank is 1.5 feet, at the angle 1 foot. As originally built it broke in several places, but was afterwards widened. The report of 1830 gives 14 inches and that of 1872 20 inches over the upper bar. The map of 1875 gives 2 feet opposite upper dam and 0.9 foot a little distance below. At present there is 3 feet opposite dam and for some distance below, and not less than 2.4 feet anywhere. This is an improvement of at least 1 foot. A dam was here before 1875, but was old and leaky. A bar will probably keep reforming where the current begins to lessen, but as yet there is no trouble from that source.

Dam No. 2. The cross part of this dam was built before 1875; the rest since that date, and the other part tightened. It is a substantially built dam, from 10 to 12 feet in width, 1 to 2 feet above low water.

The survey of 1830 calls for a general depth of 15 to 18 inches, that of 1871 20 inches. The survey of 1875 gives a depth along the chute inclosed by the dam of from 0.5 to 1 foot. The survey of 1879 after the dam was lengthened, before the longitudinal part was built, gives from 3 to 5 feet; now the least depth is 3.3 feet, and it reaches 6 feet. As the bottom is now rocky, it will probably not further deepen. The bank is cutting slightly. Behind the dam the water is shoaling. Just below the dam, on the left bank, and also to right of extremity of the dam, bars are forming that give only a few inches at low water. The fan-shaped current makes it very difficult to enter the chute.

Dam No. 3 is carefully and regularly built with riprapped sides. The intention was to keep water from taking the back chute between the islands. Its effect is not great, though it has probably caused a shoaling of channels between islands, which is of advantage.

Dam No. 4 is also regularly built, and is of advantage in keeping water in channel. Between the foot of the islands and Cox Reef, about 500 feet below the last island, the channel is irregular and rocky. It shows slightly greater depth and straighter channel than in 1875. For a mile or so below, the channel, though a little deeper, is similar. There is sufficient depth for present needs, but the channel is irregular and reefy.

From Chota Shoals to Coulter Shoals, a distance of 12,000 feet, the depth reaches 31 feet, being usually from 8 to 12 feet in the first half and over 15 feet in the second half of this distance.

Coulter Shoals extend for 6,000 feet along and below the islands of that name. They are formed by a series of rock reefs and gravel bars, with rock a short distance below the gravel. The least depth is 1.5 feet, which occurs at several places, the average depth being about 2 feet. The near vicinity of rocks and reefs and the swift current make navigation at a low stage very difficult. The fall is 7 feet in 5,000 feet, fairly evenly distributed. The improvements consist of a dam about 1,100 feet long, connecting the two islands. This dam was built in part before 1871 and finished in 1876 and 1878. Excavations of rock amounting to 100 cubic yards were also made in 1876 and 1884. The upper part of the dam is tight, and land is forming behind it. The lower part has some large gaps and is leaky.

The report of 1830 gives a depth of 15 inches; that of 1872 16 inches. The survey of 1875 gives an extreme low-water depth of 1 foot and a very crooked channel. Comparing with the present depth, there would seem a good deal of improvement. The 3-foot contour line, which in 1875 was 1,000 feet above foot of dam, is now 200 feet below it, increasing the depth over that distance nearly 2 feet; the whole channel has been made much straighter, and the passage from the foot of island to deep water is 5 to 6 inches deeper. At the same time the location and size of deep holes remaining the same shows that there is no tendency to fill.

Below Coulter Shoals the depth reaches about 12 feet for 2,500 feet. There is, then, a bar 500 or 600 feet long with a minimum depth of 4 feet. Then to Sister Island Shoals, 9,000 feet, there is a depth of 6 to 10 feet above Leepers Ferry and 10 to 21 feet below.

Sister Island Shoals lie along and be [illegible] the [illegible] They are formed by a series of reefs, covered usually with a thin layer of gravel. The least depth is 1.5, but is usually about 2 to 2.5 feet. The difficulty in navigation comes chiefly from the extreme crookedness of the channel. The fall is 4.5 feet in 7,000 feet. The improvements consist in the removal of 65 cubic yards of rock in 1876. The survey of 1830 gives a depth of 12 to 13 inches; that of 1871, 20 to 26 inches. The map of 1875 gives only 1.1 feet over the shallowest places and an exceptionally crooked channel. The gain, then, has been at least 4 inches, and a much more feasible, straighter, and better channel. The average increase in depth is about 6 inches.

Between Sister Island and Bussell Bar a depth of about 10 feet is obtained over a length of 1,500 feet.

Bussell Bar is made up of a series of bars and outcropping reefs, extending for 4,000 feet. The least depth is 2.2 feet. The fall is 1.7 feet in 2,500 feet. The improvements consisted in the removal of 184 cubic yards of rock in 1876. The survey of 1830 calls for 12 to 20 inches depth, that of 1871 for 22 inches. The map of 1875 gives only 1.3 feet. This is probably too little, but nevertheless the channel shows considerable improvement.

Between Bussell Bar and Belle Canton Shoals, 2,500 feet, the depth varies between 6 and 10 feet.

Belle Canton Shoals lie at the islands of that name. They are formed by a gravel bar, and are about 2,000 feet in length. The least depth is 2.6 feet and usually over 3 feet. The fall is 0.9 foot in 2,000 feet. There are no improvements. The survey of 1830 gives a depth of 24 inches, that of 1871 22 inches. and the map of 1875 only 17 inches. While the latter is doubtless too small, yet it is evident the channel is improving in depth. This is due to the fact of the current tending to the right-hand channel and cutting out the bottom.

From Belle Canton Shoals to Lenoir Shoals, 5,500 feet, the depth reaches 18 feet and is usually over 10 feet except over a short bar at the foot of the islands, where it is but 5 feet.

Lenoir Shoals lie below the mouth of the Little Tennessee River and opposite Lenoir City. The bar is about 500 feet long, formed by gravel and rocks. The least depth is 0.8 foot. The fall is 0.3 foot in 1,000 feet. There were some improvements prior to 1870, and 96 cubic yards of rock have been excavated since 1871. The survey of 1830 gives 18 inches; that of 1871, 12 to 13 inches; and the map of 1875, 8 or 9 inches. There is, therefore, no improvement. A deeper channel can be obtained by passing around a small island near left bank. This chute has a least depth of about 2 feet. It is, however, very narrow and swift.

From Lenoir Shoals to Browder Shoals, 20,000 feet, the depth goes to 50 feet and is usually over 20 feet.

Browder Shoals lie at the foot of Browder Island, and are formed by a reef overlaid with a few inches of gravel. The shoals are about 1,000 feet long with a fall of 0.4 foot. The least depth is 1.7, usually over 2 feet. About 400 cubic yards of rock have been removed since 1871. The report of 1830 gives 12 to 13 inches of water, that of 1872, 22 inches, and the map of 1875 1.6 or 1.7 feet. The depth to-day is about the same, but the removal of rocks has made the channel safer.

From Browder Shoals to Rock Quarry Shoal the depth varies from 10 to 30 feet over a distance of 10,000 feet.

Rock Quarry Shoal, one-half mile above Carmichael Island, is formed by a gravel bar about 600 feet long. The rock is 1 foot below the gravel. The least depth is 2.2 feet, but it is usually over 3 feet. The fall is 0.3 foot in 500 feet. There are no improvements. The survey of 1830 gives 2 feet depth, and the map of 1875 2.9 feet. There is therefore some shoaling, but not enough to be of importance. From Rock Quarry Shoal to Carmichael Shoals, 3,000 feet, the depth is from 10 to 30 feet.

Carmichael Shoals are at head of Carmichael Island. They are formed by a gravel bar 500 feet long, over which 4 feet can be found. There are no improvements, and it is not described in other surveys.

From Carmichael Shoals to Winding Shoals, 10,000 feet, the depth varies from 10 to 46 feet, and is usually over 20 feet.

Winding Shoals are formed by a gravel bar 1,500 feet in length. Rock is from 0.5 to 1 foot below bottom. The least depth is 2 feet, and varies between that and 3.5 feet. The fall is 1 foot in 500 feet. The current is swift. The river is very wide, 1,400 feet. There are no improvements. The report of 1830 gives a depth of 2 feet. That of 1872 and the map of 1875 do not describe this shoal. It appears then that it has not much changed since 1830.

From Winding Shoals to London Shoals, 5,000 feet, there is a depth from 10 to 39 feet.

London Shoals lie below London, Tenn., and consist of two separate shoals. The first is at the head of Blair Island, and is caused by a gravel and rock bar 1,000 feet long, and by several reefs near the shore. The least depth is 3 feet, but the small width of the channel, the necessity of keeping close to the reefs, and the swift current make the passage dangerous. The narrowness of the spans of the East Tennessee, Virginia and Georgia Railroad Bridge, crossing at the head of the shoals, increases the difficulties of navigation. Below the bar for 2,000 feet the depth varies from 5 to 10 feet with rock bottom. The lower part of the shoal is formed by a rock reef extending out from left bank, and by a series of other reefs near to which the channel runs. The length is 2,500 feet. The least depth is 2.8 feet, but the navigation is difficult for the same reasons as above. The total fall is 3.7 feet, the greatest is 1.5 feet in 1,000 feet. There are no improvements. The examination of 1830 does not give any depth; that of 1871 gives 30 inches; the map of 1875 does not extend below Rock Quarry Shoal. It is difficult to say whether there has been any change.

From Loudon Shoals to Harrison Shoals, 10,000 feet, the depth is from 7 to 20 feet.

Harrison Shoals, at Harrison Towhead, are formed by a gravel bar about 500 feet long, with 4 feet at low water. There are no improvements.

From Harrison Shoals to Sweetwater Shoals, a distance of 16,000 feet, the depth is from 10 to 41 feet, usually over 20 feet.

Sweetwater Shoals lie along Sweetwater or Ray Island. They are formed principally by two gravel bars 300 feet long, one lying at the head and one at foot of island, separated by about 2,000 feet. The total fall in a mile is 2 feet. The least depth over the upper bar is about 1 foot, and over the lower 2 feet.

Improvements: A dam was built in 1873 and 1874 1,600 feet long, 8 feet wide, of regular shape, and about 2 feet above low water. It is very nearly parallel to the left bank and does not hold water up much, there being only about 6 inches between the two sides of dam at a 1-foot stage. The bank at lower end of dam forms a pocket called Sweetwater Pocket. Although the water is forced over against the bank by the dam the pocket is filling up on the side of bank. One hundred and ten cubic yards of gravel were removed in 1873. The report of 1830 gives 15 and 18 inches, that of 1872 20 inches. The dam has apparently not been of much service. As the pocket fills up, however, the channel will probably improve. Ground is forming behind the dam.

From foot of Sweetwater Shoals to head of Bogart Island, 2,700 feet, the depth is from 5 to 10 feet, with rocky bottom and occasional reefs. From that point to head of Lower Bogart Island the depth is from 4 to 7 feet.

Bogart Shoals extend from near the foot of the first island to below the second, a distance of 3,000 feet. They are formed by a series of gravel-covered rocky reefs. The rock is from 0 to 2 feet below the surface. The fall is 1.7 feet in 3,000 feet. The least depth is 1.6 feet. The improvements are a dam 1,300 feet long, extending partly across the river and then downstream as a longitudinal training wall. It was built before 1871, but extended and strengthened in 1873. It is about 20 feet wide and from 0 to 3 feet above low water. The part near bank is old and allows water to pass over. The elbow is high and covered with willows. The lower end of longitudinal part is also low. This dam is built too far upstream for a good effect. There were 170 cubic yards of rock removed in 1873 and 1874 at foot of lower island. The report of 1871 gives 24 to 30 inches of water. There seems a shoaling just above the elbow of dam. The channel below dam is crooked and reefy.

From Bogart Shoals to Bacon Shoals, 8,000 feet, the depth is usually 6 to 8 feet, sometimes reaching 10 feet. Rock bottom is found and some reefs.

Bacon Shoals are formed by a series of gravel bars extending over 2,500 feet, with a depth of 1.6 to 3 feet. Rock lies 2 or 3 feet below bed. There are no improvements. Examinations of 1830 and 1871 give 24 inches.

From Bacon Shoals to Wilson Shoals, 3½ miles, the depth reaches 41 feet, averaging 10 to 15 feet up to Pond Creek and 20 feet below.

Wilson Shoals lie at the head of Wilson Island, and are formed by several rock reefs extending out in the river; through gaps in these reefs the channel runs. The least depth is 2 feet and the fall 0.9 foot in 1,500 feet. The improvements consist in the excavation of 56 cubic yards in 1874 at head of island, and of a dam built across the head of island. This dam, 400 feet long, is 8 feet wide at head, regularly built, leaks a little, is 2 feet above low water, and holds water up about 1.5 feet at a low stage. The former examinations do not give the depths at this place.

From the foot of Wilson Shoals to Seven Islands, a distance of 1½ miles, the depth reaches 29 feet and is usually over 15 feet.

Seven Islands Shoals occur at the islands of that name. Most of the water usually passes through a broad channel to the left of the islands. The steamboat channel takes a narrow chute to the right. There are several shallow places along the islands, which extend about 1¾ miles. At head of islands a series of gravel bars, extending almost the whole length of the first island, gives a least depth of 2.2 feet, and usually about 2.5 to 3 feet. Near the lower end of the first island is a rocky reef. The fall is 1.7 feet in 3,500 feet. The improvement consists in the removal of about 80 cubic yards of rock near the reef in 1874 and 1875. The report of 1830 gives 12 to 13 inches; that of 1872, 30 inches.

From foot of this part of the shoals to Farmer Bar, 3,000 feet, the depth varies from 3 to 10 feet.

Farmer Bar is formed by a rocky reef, with a least depth of about 2 feet in 1,200 feet, a fall of 1.1 feet in 500. The current is very swift. It is considered the worst point between Kingston and London. The improvements consist of two dams. Dam No. 1, between islands, is 9 feet wide, tight, regularly laid with sides riprapped, and 2 feet above low water. It holds up the water 1.3 feet. The lower dam, containing a cross and longitudinal part, is 9 feet wide, with regular faces. The cross part is 2 feet above low water and has several gaps; the longitudinal part is 3 feet above water, tight, and overgrown with willows. The current is very swift. The examination of 1830 gives 15 inches; that of 1871, 30 inches. As the bottom is rock and the dam clearly holds up water, there is evidently a gain in depth. There may be some shoaling below the end of dam. This dam is built on the reef itself and causes the fall to occur at one place, making it very sudden and the current swift. It should have been located 100 feet or more downstream.

From foot of Seven Islands Shoals to head of Long Island, about 1 mile, the depth reaches 30 feet and is usually about 25 feet.

Long Island is about 3 miles long. There are shoals at several points. The total fall is 4.5 feet. The first shoal is at head of Long Island. It is formed by a gravel bar, with a least depth of 1.5 feet and a usual depth of 2 to 5 feet. The fall is 0.6 foot in 1,000 feet. The examination of 1830 gives 15 inches; that of 1871, 20 inches. For a mile below the depth is from 3.5 to 9 feet. The second obstruction is caused by a reef covered with gravel. The least depth is 2.3 feet for 1,000 feet—the usual depth varies between that and 3 feet. The fall in 1,000 feet is 0.4 foot. Below the reef for 4,000 feet the depth varies between 4 and 7 feet. The third obstruction is a gravel bar, with a least depth of 1.9 and a depth of less than 3 feet for 300 feet. From this bar to end of island the depth goes from 3.2 to 10 feet. The examination of 1830 gives 10 inches; that of 1871, 20 inches (this latter for the whole length of island). The improvements consist of dams across all the chutes at the head of the islands, built in 1875 and 1876. Some old dams existed before that time. The first dam is 9 feet wide, regular faces, fairly tight, 2 feet above low water; 2 gaps allow the passage of water at ordinary stage; it holds up water 1.5 feet. The second dam is 8 feet wide, 1.5 feet above low water, has regular faces; it is in bad repair, leaking in upper part; it holds up water 1.3 feet. The third dam is 8 feet wide, with regular faces, tight, and calked with earth and vegetation, 2 feet above water. At lower end is a gap 50 feet wide, through which much water is wasted. It holds up water 0.6 foot. The fourth dam is roughly built of cribwork, leaky, 6 inches to 2 feet above low water, holds water 0.9 foot.

From foot of Long Island to Clinch River, 1¾ miles, the river reaches 43 feet depth, and is usually over 20 feet. Up the Clinch River to Kingston, about 1 mile, the depth is generally 5 to 7 feet.

From the mouth of the Clinch River to the head of Caney Creek Shoals, 4 miles, the depth reaches 57 feet, and generally is over 20 feet.

Caney Creek Shoals are the most important obstructions above Chattanooga. They extend a distance of about 5 miles, and are now known under the names of Caney Creek Shoals, Turner Bar, and Shields Dam. The fall is 10 feet.

Caney Creek Shoals proper lie above and along Caney Creek Island and opposite Caney Creek. They are formed by a series of rocky reefs, extending 6,000 feet, with a fall of 5 feet, a least depth of 1.5 feet, and an average depth of scarcely more than 2 feet. The channel, moreover, is crooked and difficult, passing at several places so close to reefs as to make it dangerous. The current is swift. At several points it is impossible for two vessels to pass. Generally the rock is at the surface of bottom and always but a few inches below. To the left of Caney Island there is, at the head of island, a rocky ledge about 1,000 feet long, with a depth of 0.5 foot to 1.5 feet. Below this ledge the water is from 3 to 5 feet deep. It has been proposed to make this chute the main channel. This change is not recommended, as the distance is so much shorter, which is usually a disadvantage, and the cost of blasting a channel through this reef would be large and the sudden fall would make it difficult to navigate.

The improvements at these shoals consist in the removal in 1872 and 1873 of 450 cubic yards of rock from the reef lying near the central point and at the end of the principal dam, and in the construction of three dams. The upper of these dams is 1,000 feet long, 10 feet wide, roughly built, tight, filled with earth and plants, and is 2 to 3 feet above low water. It forms a narrow channel chute at its lower end, but does not open enough at head to take much water. One of the shallowest points on the shoal is 100 feet below the foot of this dam at place called "the Pocket." The bank is cutting a little here. This dam was built in 1856, and afterwards repaired and enlarged in 1872. The second dam starts from the left bank, straight across toward the right bank, and then follows down parallel to the bank, a total length of 3,800 feet. The upper part, 1,400 feet in length, was built before 1871. It is roughly built, from 0 to 1 foot below the surface of low water, has numerous gaps, and, of course, allows much water to pass. From the first elbow down, 2,400 feet, the dam is 10 to 15 feet wide, has regular faces is filled up with vegetation, and perfectly tight. It confines the water collected, but does not collect much. This lower part was built in 1873. The water is held up at the upper angle only 0.5 foot. The third dam has a cross part 500 feet in length, and a longitudinal part the same length; it is 7 to 8 feet wide, has regular faces, is 1.5 to 2 feet above low water; it is not quite tight, but apparently is filling up. At the elbow of dam is a prominent reef that acts as a dam, the fall being 1 foot in 300 feet, and at the foot of the dam is another similar reef. The removal of these two reefs would probably lower the water above considerably. The dam was mainly built in 1875, with some work in 1888. This dam assists over the two reefs mentioned, but the passage is dangerous.

The examination of 1830 gives 12 inches of water; that of 1871, 20 inches. There is therefore a better channel now than before. One thousand feet below the creek the river deepens to from 3 to 5 feet, the channel passing near the island. It then shallows to between 2 and 6 feet down to Turner Bar, a mile below. The channel is crooked and reefy. Boats in low water have to work in around the reefs, and this in windy weather is difficult and dangerous.

Turner Bar proper is a rock reef extending across the river. The least depth is 2.2 feet. The improvements consist in the removal from 1873 to 1876 of 450 cubic yards of rock and gravel. At the reef itself there is better depth now than at other places. The examination of 1830 gives 12 inches; that of 1875, 15 inches.

Below Turner Bar for 3,000 feet the channel is crooked, rocky, with a depth varying from 1.4 to 6 feet. Below this distance, down to Shields Dam, the channel improves, being usually from 3 to 5 feet deep, and the reefs not being so numerous or dangerous as above. The bottom is usually gravel, with rock 1 foot below.

Shields Dam: The obstruction here is caused by a rock bar 1,500 feet long, with a least depth of 1.8 feet and an average of 2 feet. The improvements consist of an old roughly built dam, built before 1871, from 0 to 2 feet below low water, and of a longitudinal dam built since that date. The latter is 1,000 feet long, built of crib work filled with rock, is 6 feet wide at upper end, 25 near lower end, and from 0 to 2 feet above low water. The lower 300 or 400 feet of the dam are much more substantial than the rest, and are covered with earth and willows.

For 4,000 feet below Shields Dam the depth is from 3 to 5 feet and the bottom reefy.

Thence to King Bar, nearly 3 miles, the water reaches 24 feet and is usually from 10 to 15 feet, except over a bar 1,000 feet long, where it is about 5.5 feet.

King Bar is formed by a gravel and rocky bar extending across the river, with the central part bare at low water. The least depth is 1.5 feet over a length of 100 feet; the usual depth is from 2 to 3 feet over 1,500 feet, the fall 0.5 foot in 2,000 feet. There are no improvements. The examination of 1830 gives 18 inches; that of 1871 does not describe this bar. There would seem to be a slight shoaling, which is probable.

From King Bar to Rockwood Landing, 7,500 feet, the depth is from 5 to 15 feet. From Rockwood to Brackett Bar, 5,000 feet, the depth is from 3 to 5 feet.

Brackett Bar is a gravel bar with a least depth of 1.5 feet, and a general depth of less than 2.5 feet over a distance of 2,000 feet. It is not described in previous reports.

From Brackett Bar to Half Moon Shoals, 4,000 feet, the depth is from 10 to 15 feet.

Half Moon Shoals are located from 2,000 feet above Half Moon Island and two smaller islands to below the foot of the islands, a distance of 5¼ miles, with a total fall of 7.5 feet, quite evenly distributed. The wider and shorter channel goes to the right of islands, but it is very shallow. The channel to the left is narrow and longer, and much better adapted to low-water navigation. The first obstructions lie 2,000 feet above the head of the first island, and consist of reefs and gravel shoals over an extent of 4,000 feet; the least depths are 1.6 to 2 feet, with an average depth of about 3 feet. The rock is everywhere within a few inches of the bottom. The fall in 4,000 feet is about 0.5 foot. From this point, 600 feet below the head of the main island, the depth varies from 3.5 to 8 feet; for the subsequent 7,000 feet there is from 2.9 to 7 feet, usually over 3.5 feet depth. The shallow places occur at various points, and are rock bars covered with a layer of gravel. For the next 1,500 feet the depth varies usually from 3 to 5 feet, not exceeding the latter at any place, and usually about 3.5 feet, except at three places, each 200 or 300 feet in length, where the depth is in one case as little as 2.2 feet, and in the others 2.8 feet. At one place a reef of rocks extends nearly across the chute. For 2,000 feet above the foot of the island the depth varies from 2.2 to 4 feet, the bottom is reefy; at the foot of island there is a fall of 1.5 feet in 800 feet.

The improvements consist in the removal of about 130 cubic yards of rock and 200 yards of gravel, mostly at foot of island, and the building of four dams, three at the head and one at foot of the islands. Dams at the head of island were built before 1871. They were of little use. New dams were built and repairs made in 1873, 1876, 1886, and 1887. The uppermost old dam was abandoned and a new dam 1,100 feet long built in 1873. This dam is 2 feet above low water, 15 feet wide, roughly built, but tight; land is forming rapidly, especially about the island. Dam No. 2, 665 feet long, is an old dam repaired; it is 10 feet wide, of crib work filled with large bowlders. It is as much as 4 feet above low water in places. At the upper end land is forming rapidly, but at the lower end water flows through at ordinary stages. It holds up water 3 feet. No. 3, 300 feet long, is likewise an old dam repaired. It is roughly built, but solid and quite tight; water flows through a little; the lower part is crib work; it holds up water 2.7 feet; land is forming behind. The dam at the foot is 9 feet wide with regular faces, from 0.1 foot to 2 feet above low water, somewhat leaky and no earth depositing. The island opposite dam is riprapped to 1.5 feet above low water. Rock is within a few inches of bottom, Opposite the dam there is 3.5 feet of water, but it is only 2.5 feet deep above the dam and the same below. Reefs projecting from the left bank make the entrance to lower end difficult. For 500 feet below the island the depth varies from 2.5 to 5 feet, but the reefs hinder navigation to some extent. The examination of 1830 does not state depth; that of 1871 gives 16 inches and a crooked channel; this would show considerable improvement.

From Half Moon Shoals to White Creek Shoals, 1 mile, the depth is from 7 to 16 feet.

White Creek Shoals lie below the creek and above and below the islands of that name. The old channel went between the islands and was crooked, shallow, and dangerous. The present channel goes between the left bank and the islands. The obstructions consist of a number of reefs and gravel bars with a least depth of 2.1 feet and an ordinary depth for 9,000 feet of from 2.5 to 4 feet. Below the foot of dams a sand bar forms at high water, but is usually cut away as the water falls. The improvements consist in the removal of 60 cubic yards of rock and 90 of gravel in 1872 and in the construction of a long series of dams, built in part before 1871 and continued in 1872, 1873, 1874, 1888, 1889, and 1890. The total fall is 6.5 feet, evenly distributed. The first dam, 750 feet in length, reaches to within 300 feet of right bank. It is 10 feet wide at top, 2.5 to 3 feet above low water, roughly built, and is filling up a little with earth. As there is very little difference in head on the two sides it is difficult to determine tightness.

The second dam continues from first towhead to island, passing over the second towhead, is 2,400 feet in length, the upper part roughly, the lower part more regularly built, 10 feet wide, 2.5 feet above low water, tight, and in general is a good dam. Earth is forming behind and the towheads are increasing in size. Above second towhead the dam holds water up 2.3 feet and above the island 1.4 feet. Below the islands the dams consist of a longitudinal part 1,700 feet long, and two check dams 140 and 170 feet long. The former is 8 feet wide 2.5 above low water, roughly built, but is filling up. Below upper check dam it is more regularly built and 4 feet above low water. It holds the water up 1.4 feet. The upper check dam is of loose rocks to 3 feet above low water, holds water up 0.6 foot. The lower check dam is about the same; it holds water up 1.3 feet at the angle. The object of the check dams is to cause deposits below and behind them, and to carry away the sand bar. It seems to be accomplishing that end. The bank is cutting near lower end on island and on left bank opposite lower end of dam.

Examination of 1830 gives 16 inches; that of 1871 17 inches. An examination of 1888 gives the same profiles as to-day, except that the sand bar has been moved down, due to the new dams. The improvement is considered as one of the most successful on the river. The old channel was between the islands, difficult and shallow. The present channel was formerly nearly dry.

From White Creek Shoals to Gillespie Bar, 3 miles, the depth varies from 5 to 13 feet and is usually about 8 or 9.

Gillespie Bar is formed by a series of gravel bars, with occasional rock, stretching across a wide piece of river. The first bar puts out from the right bank, and gives a depth of 2.5 feet over 250 feet; then comes a stretch of 2,500 feet where the depth is from 5 to 10 feet, along a narrow channel, and then the main bar appears, with a minimum depth of 1.3 feet and a depth of less than 3 feet for 1,000 feet, the channel crossing from left to right bank. The fall is 0.5 foot. There are no improvements. The examination of 1830 gives 16 inches; that of 1871 does not describe this bar. There seems to be a little shoaling.

From Gillespie Bar to Preston Island, 3 miles, the depth reaches 52 feet and is generally over 15 feet. At the island it shallows to from 5 to 8 feet, and about the middle is a reef extending nearly across the river, affording, however, a passage of 5.5 feet depth.

From Preston Island to head of Fouchee Island, 2¼ miles, the depth reaches 26 feet, and is usually from 10 to 15 feet. For 1,000 feet below the head of Fouchee

Island the depth is from 3.5 to 7 feet, with a bad reef close to which the channel passes.

From Fouchee Island to Piney Island, 1¼ miles, the depth reaches 30 feet and is usually over 15 feet. Along Piney Island for 6,000 feet the depth is from 4.3 to 12 feet, usually 6 to 8 feet. From the lower part of island to Watts Bar, 1¼ miles, the depth is from 15 to 30 feet.

Watts Bar is formed principally by a narrow prominent reef extending across the river near head of Watts Island, and by a series of shallows of gravel and rock, in all over 11,000 feet in length. The fall is 3.3 feet, of which 1.5 feet occur in the first 3,000 feet. The least depth is 2 feet, the usual depth from 3 to 4 feet. The bottom is rock or gravel with rock a few inches below.

The improvements consist in the excavation of about 288 cubic yards of rock at the reef and of 185 cubic yards of gravel, and in the construction of the three dams. The work was done in 1872, 1873, and 1874. The main dam contracts the water from the right bank. It starts opposite head of island 200 feet from right bank; is 1,300 feet long, 8 to 10 feet wide, semiregularly built, seems tight and filling up, especially near the lower end; 1 to 3 feet above low water. Second dam, across head of island, 235 feet long, 8 to 9 feet wide, semiregularly built, tight, filling up, 1.5 to 2 feet above low water, holds up water 1.5 feet. Third dam, across slough, 6 to 8 feet wide, semiregularly built, tight, 1.5 to 2 feet above water. The slough is nearly dry.

Former examinations give 16 inches, and it is well known that previous to the improvements the bar was the first hindrance to navigation as the water fell, and often the limit of the same, and that the improvement allows boats to pass at stages formerly impossible. Its age, nearly twenty years, shows the permanency of improvements on this river. An examination of 1888 gives substantially the same curves as to-day. It is probable that if this dam had been located farther downstream it would have been better.

For 3,000 feet farther down the depth does not exceed 10 feet. From thence to Hunter Island, 6 miles, through Stewart Eddy, the depth reaches 43 feet and is usually over 15 feet.

Hunter Shoals lie at Hunter Island, and are formed by a gravel bar 4,000 feet in length extending out from left bank. The least depth is 2.4 feet and the usual depth from 3 to 4 feet. The fall is 1 foot. There are no improvements. Depths are not stated in previous examinations. From Hunter Shoals to 1,000 feet above Washington Ferry, 3 miles down, the depth varies from 7 to 15 feet.

Over the next 5 miles occurs an almost continuous series of shoals, going by the names of Washington, Hazleridge, and Goodfield shoals. The river is wide, and bars and reefs very numerous. The total fall in 5 miles is about 5 feet. From 1,000 feet above Washington Ferry to Robinsons Landing, 6,000 feet, the least depth is 2 feet and the usual one about 2.5 feet. The channel is narrow and the bottom rocky. For 3,000 feet farther down the depth increases to from 3.5 to 5 feet. Then comes a series of reefs for 2,000 feet with a least depth of 2 feet, an average of 2.5, with a dangerous channel and occasional bowlders; then comes 2,000 feet with a depth of 3.5 to 5 feet. For the next 6,000 feet the depth varies between 2 and 4.5 feet, usually not far from 3, the bottom being a succession of bars of gravel and rock, with rock always near the surface. For 6,500 feet farther down is a succession of gravel bars with occasional rock. The least depth is about 1 foot and is under 2 feet for a length of nearly 2,000 feet. The remaining 4,500 feet have a depth of 2 to 2.5 feet, occasionally of 5 feet.

The improvements consist in the excavation of 255 cubic yards rock in 1874, 1875, and 1876 at the reefs known as the Hazleridge Shoals.

From foot of Goodfield Shoals to the beginning of Kelly Shoals, 4,300 feet, the depth is from 8 to 11 feet.

Kelly Shoals are formed by a series of reefs and bars over 9,000 feet in length. The total fall is 2.2 feet, of which 1.5 feet are in the last 2,000 feet. The least depth is 2.5 feet 4,000 feet above the dam, and at dam 2.6 feet. Usual depth is from 3.5 to 5 feet. The channel is crooked, going from one side to the other, and the passage difficult. There are numerous reefs. The improvements consist of the removal of 35.9 cubic yards rock in 1873, 1874, and 1876, and of the building of a dam near the lower end of shoal in 1876 and later. This dam is 1,250 feet long, is 9 to 10 feet wide, 2.5 above low water, and leaks some. The longitudinal part is covered with vegetation. It holds up water at center 0.7 foot. The examination of 1830 does not give depth; that of 1871 gives 18 inches. An examination in 1888 gives nearly the same contour as to-day. There is, therefore, considerable improvement, but this is still considered, however, a difficult point to pass.

From Kelly Shoals to Martin Bar, 5,000 feet, the depth is from 5 to 8 feet.

Martin Bar is a narrow gravel bar giving a depth of 3 to 4 feet over a length of 1,000 feet. The fall is 1 foot in 3,000 feet. There are no improvements. It is not described in other examinations.

From Martin Bar to Chatton Shoals, 8,000 feet, the depth is from 5 to 10 feet.

Chatton Shoals are formed by a gravel bar 7,000 feet in length, with a depth of from 3.5 to 4.5 feet.

For 6,000 feet below, the depth is from 5 to 11 feet, then through Bell Eddy, 22,000 feet, the depth varies from 10 to 27 feet up to Hiwassee Shoals.

Hiwassee Shoals lie at several places along Hiwassee Island. The channel is to right of all islands. The first obstructions are two gravel bars, the first with a depth of 3.5 feet, and the second 2.2 feet over a length of 200 feet. They are separated by a stretch of 3,000 feet, where the depth is between 4 and 5 feet. The fall is 1 foot in 4,000 feet. From the foot of small island to 1,000 feet above foot of large island, a distance of 8,000 feet, the depth varies from 7 to 10 feet. Near the foot of island is a gravel bar with a least depth of 3.5 feet over a distance of 200 feet. The examination of 1830 gives a least depth of 20 inches. The shoal is not described in examination of 1871. There are no improvements. The channel seems improving.

From Hiwassee Shoals to Sale Creek Shoals, 3 miles, the depth varies from 4.5 to 20 feet, being usually about 7 or 8.

Sale Creek Shoals are formed by a long series of gravel bars with occasional reefs extending from 3,500 feet above upper Sale Island to 3,000 feet below lower Sale Island, a distance of 17,000 feet. The least depth is 2.2 feet, occurring at several places. The total fall is 4 feet, evenly distributed. Above upper Sale Creek Island the least depth is 2.6 feet for about 300 feet, then it varies between 3 and 5 feet, being usually about 3.5 feet. Along the upper island the depth varies from 3 to 4.5 feet, except over a stretch of 600 feet where there is from 2.6 to 3 feet, and over one of 500 feet where there is from 2.2 to 2.8 feet. Between the islands the depth is from 2.2 to 4.5 feet. The rock is only a few inches below the bed. Just below the mouth of the creek is a hole 1,000 feet long with a depth of 4 to 10 feet. Below this hole is a second bar coming out from the right bank, forcing the channel very near the island. Along the island is a stretch of 800 feet where the depth is from 2.2 to 3 feet and the remainder is from 3.5 to 5.2 feet. The river to left of islands is wide and shallow. Large gravel bars exist at the heads of both islands. One thousand feet below lower island is another bar giving from 2.2 to 3 feet over a distance of 1,500 feet. This is known as Cross Bar. The improvements over Sale Creek Shoals and Cross Bar consist in the removal of snags and in 217 cubic yards of excavation in 1873. The examination of 1830 gives 20 inches; that of 1871 does not describe these shoals. There seems, therefore, an improvement. To-day the channel is shoaling

From Cross Bar for 8,000 feet the depth is from 5 to 8 feet, averaging 6.5 feet. A continuation of comparatively shoal water over 10,000 feet goes by the names of Thatcher and Eldridge bars. The first has an average depth of 3.5 feet over 5,000 feet, with a least depth in one case of 3 feet. Then comes 3,000 feet of from 4.5 to 6 feet, and then 2,000 feet from 4.2 to 5 feet, called Eldridge bar. From these bars to Soddy Shoals, 5,000 feet, the depth is from 5 to 10 feet.

Soddy Shoals are a long succession of shoals beginning 5,000 feet above Soddy Island and extending 10,000 feet below, a total distance of 20,000 feet. The total fall is 6.5 feet, the greatest fall being at foot of lowest dam, where 0.8 foot fall occurs in 600 feet. The shoals are occasioned by a series of gravel bars and a number of reefs rising often to surface of low water and giving a difficult and dangerous channel. Above the islands for 5,000 feet the obstruction is a continuous gravel bar with a depth of from 3.2 to 4.5 feet. Along the islands to within 500 feet of foot the depth is from 4.5 to 6 feet. At the point near the foot is a reef that gives 3 feet along crooked channel. From foot of island to end of long dam, 3,300 feet, the depth varies usually from 1.8 to 2.5 feet, with a gravel bottom and rock about 1 foot below. For 2,000 feet farther down the depth is from 1.9 to 2.5 feet, with numerous reefs, making a difficult channel. From here to end of shoal the depth varies between 3 and 6 feet, but reefs on both sides of channel render it narrow and dangerous.

*Improvements.*—Before 1871 a dam was built across from upper island to left bank, another between the two islands, and a short dam below. The old upper dam is leaky, low, and of little use. In 1872, 1873, 1874, 1875, 1876, 1888, and 1890 the improvements were continued. A new dam was built from head of island 1,050 feet long, 6 to 9 feet wide, semiregular in construction, 3 feet above low water, perfectly tight, and filling up, especially near island. It holds water up 0.5 foot. Between the islands is a dam about 500 feet long, 10 feet wide, 2 or 3 feet above low water, and semiregularly built. Between the islands it is filling. It holds up water 1.8 feet. Below the island is a dam 3,250 feet long. It is 8 feet wide, semiregularly built, 2 to 3 feet above low water, leaks badly, is filling up some at angle below. Holds up water at foot of island 1.3 feet. Below is a dam 1,000 feet long, 8 to 9 feet wide, semiregularly built, 3 feet above water, tight, and filling up. It holds up water 0.3 foot. Besides these dams rock to the amount of 46 cubic yards has been removed in 1872, 1873, 1874, 1875, and 1888.

The examination of 1830 calls this one of the most difficult shoals, but does not state depth. That of 1871 gives 20 inches over reefs and 15 inches over gravel bars.

The principal difficulty now, according to pilots, arises from the reefs and crooked channel, but there has been a great improvement. From the foot of Soddy Shoals to Blue Spring, 9,000 feet, the depth is from 5 to 16 feet. From Blue Spring to Dallas Shoals, 17,000 feet, the depth reaches 35 feet and is usually about 15 feet.

Dallas Shoals are formed by a gravel bar at the head and another at the foot of Dallas Island. The first gives a depth of 3 feet over 200 feet and the second of 2 to 3 feet over 2,500 feet. They are separated by a stretch of 6,500 feet, with a depth of 4.5 to 9 feet.

From Dallas Shoals to Harrison Bar, 5,000 feet, the depth is from 15 to 33 feet.

Harrison Bar, formed by a reef and a gravel bar, extends a length of 1,500 feet with a depth of 3.2 to 4.5 feet. The channel is narrow, the current swift, and there are numerous rocks.

From Harrison Bar to Layman Bar, 13,000 feet, the depth reaches 30 feet. There is a bar 1,000 feet long about half way, with a least depth of 4.5 feet and a usual depth of about 6 feet.

Layman Bar gives a least depth of 2.5 and an average of 3 to 4 feet over a length of 1,300 feet. The river is wide, and a good deal of the bottom becomes bare at low water. The rock is 0.5 to 1 foot below bottom.

Between Layman Bar and Shoemaker Bar 8,000 feet, the depth is from 5 to 7 feet.

Shoemaker Bar is a gravel bar with a least depth of 3.5 feet and a depth of less than 4 feet for 400 feet.

From Shoemaker Bar to Chickamauga Shoals, 6,000 feet, the depth is from 7 to 12 feet.

North Chickamauga Shoals lie at head and foot of North Chickamauga Island. The first is caused by a gravel bar having a depth of 3.2 to 4 feet over 1,000 feet with a fall of 0.5 foot; then comes a stretch of 5,000 feet, with a depth of 5 to 8 feet, then a gravel bar 1,600 feet in length extending to Cincinnati Southern Railroad Bridge, with a depth of 2.1 to 2.7 feet, and a narrow channel close to the bank. Rock is 0.5 to 1 foot below bottom. The examination of 1830 gives 24 inches depth.

The railroad bridge is a considerable obstruction at stages when the draw has to be used. Below the bridge the channel improves and from there to Colwell Bar, 9,000 feet below, the depth is from 5 to 20 feet, usually 6 to 10 feet.

Colwell Bar lies opposite and above South Chickamauga Creek. This obstruction is a gravel bar in the middle of a wide river, with a channel on either side. There are a good many snags. The best channel is on the right bank and gives a least depth of 1.8 feet and a depth of from 1.8 to 3.5 feet over a length of 4,000 feet. The bottom is gravel with rock from 0.1 to 1 foot below the surface. The fall is 1.5 feet in 5,000 feet.

From Colwell Bar to Crutchfield Bar, 4,000 feet, the depth is from 5 to 8 feet.

Crutchfield Bar is a gravel bar having a depth of from 3.7 to 5 feet over a distance of 1,000 feet. Rock is 0 to 1 foot below gravel.

From Crutchfield Bar to Citico Bar, 8,000 feet, the depth is from 5 to 13 feet.

Citico Bar is a gravel bar with a least depth of 2.4 feet and less than 3 over 1,000 feet. Rock is at 2 to 3 feet below bottom.

From Citico Bar to Chattanooga Shoal, 1,500 feet, the depth is from 4 to 5.3 feet.

Chattanooga Shoal lies along Chattanooga Island, and is caused by gravel bars. The least depth is 2.3 feet and the average from 2.3 to 3 feet over 1,500 feet. Towards the foot of island the depth increases to from 3 to 4.5 feet. The fall in 5,000 feet is 2 feet. Rock is near the bottom. The channel is somewhat crooked.

The depth of the river in front of Chattanooga Landing is from 6 to 10 feet.

Below Soddy Shoals there are no improvements.

## IV.—PROJECT FOR IMPROVEMENT.

The act of Congress previously cited appropriating for the survey of the Tennessee River above Chattanooga requires information as to the extent to which the river can be made navigable, the cost of the work, and the preparation of suitable plans therefor.

### EXTENT TO WHICH THE RIVER CAN BE MADE NAVIGABLE.

The Muscle Shoals Canal, which limits the navigable depth of the lower Tennessee River, is designed for a 5-foot navigation, and this would seem to be the extreme depth called for. The question is if this can be obtained above Chattanooga, it can evidently be reached by a system of locks and dams, either complete or only at the worst shoals, such as Little River, Lyons, Chota, Coulter, Caney Creek, Hazleridge Shoals, etc., and becomes simply a matter of cost.

To ascertain whether this depth could be secured by confining the water to a narrower channel, use was made of formulæ for flow of water. These formulæ are admittedly indeterminate for rivers with an uneven, varying bottom. Kutter's formula, $v = c\sqrt{RS}$, with $n$ taken at 0.030, and other formulæ out of Trautwine's Engineer's Pocket-Book were used. The slopes were calculated corresponding to the observed discharges with assumed widths of from 100 to 400 feet and depths of 3 and 5 feet. The width corresponding to the slope coming nearest within the observed slope at the different shoals was adopted as the proper width at that point. At certain places on the river, as at Little River and Chota Shoals, where most of the water at low stages is confined to a narrow chute, the approximate truth of the results obtained is shown.

Taking a conservative estimate it would seem that the following widths for a 5-foot channel can be obtained: From the junction of the French Broad and Holston rivers to the Little Tennessee River, about 200 feet, except at Little River, Lyons, and Chota shoals, where it might be only 150 feet at the points of greatest fall; from the Little Tennessee to the Clinch River, about 250 feet; thence to the Hiwassee River, about 300 feet, and below that river to Chattanooga, about 400 feet. These widths would be ample for the commerce of to-day. The improvement would be obtained by confining all the water to the channel by dams, prolonging the fall to deep water, providing means to get rid of gravel brought down, and probably using bank protection a great part of the length improved.

While a 5-foot navigation is a possibility, the nature and amount of commerce do not to-day warrant the great expense necessary. An all-the-year 5-foot navigation would undoubtedly promote commerce, but not to an extent commensurate with the great cost. The freights carried are mostly goods more or less imperishable, and could be kept over if necessary for boating stages. A clear 3-foot channel free from rocks, reefs, cross-currents, snags, and other obstructions will fulfill all legitimate demands of to-day and for many years. This has been the plan of improvement, but even in the improved places a 3-foot depth throughout has rarely been obtained.

## COST.

A detailed estimate of the cost of the improvement to secure a depth of 3 feet is given below. It amounts to $600,000. The length of the sections to be improved is 25½ miles and the cost averages $23,500 per mile.

The estimate of cost of a 5-foot channel from known data is somewhat indefinite. The length to be improved is 65 miles. The system of dams would have to be much more extensive than for a 3-foot channel, and the dams at least 2 feet higher and proportionately wider and stronger. The bank would need to be more thoroughly protected. The cost per mile would probably be double, or say $45,000. The total estimate would then become $3,000,000.

If the river be canalized it will necessitate the construction of eighteen locks having an average lift of 10 feet. The average cost would be $400,000, or in all $7,200,000. The cost of maintenance of the canal system would be about $60,000 per annum.

The 3-foot navigation seems the only one that needs to be considered in making plans. A general statement of the approximate amount of work at each shoal is given below. It is not deemed advisable to try to locate the dams at present, as the work on this river is still largely experimental; many dams can best be located only after the work is begun and the effects of dams built ascertained, and changes in the bed of the river from year to year would call for changes in the dams. Any definite location to-day would therefore be of little value and not likely to be followed with success.

For similar reasons it is deemed undesirable to state a definite width to give the chutes. This width would vary at each shoal, as on account of velocity of current the channel should be contracted only sufficiently to obtain the required depth.

The general plan would be to contract the channel by longitudinal and check dams, blast out rocks and reefs, prolong the falls to deep water, dredge out gravel and sand, etc. From experience on this river and its tributaries check dams nearly perpendicular to the current are more efficacious than longitudinal dams. They dispose better of the material carried down. In places where the river is very wide, longitudical dams with check dams built out answer well, as at White Creek Shoals. After this work is completed a yearly expenditure of about $10,000 to 15,000 would be needed for repairs and maintenance.

The best plan of operations would be to commence at the obstructions that most impede the commerce of to-day, to work at a plan for 3-foot navigation, though not necessarily obtaining that depth at the first improvement, and then gradually, as commerce grows and distributes itself, extend the work. This plan is not antagonistic to a 5-foot plan of navigation, which would be an elaboration of a 3-foot plan.

The cost of dams varies between wide limits, owing to the nature of the rock, the distance it has to be carried, and the stage of water when work is being prosecuted. A fall of a few inches at low stages may double the cost of transportation. Rock excavation is likewise subject to great fluctuations, due to kind of rock and stages of water, the season of work, etc. For dam building a stage of water of 1¼ to 2 feet is desirable, while for excavation the lower the stage the better. Therefore a general estimate of cost for the whole river is the only reliable one. An estimate of $2 a cubic yard for dams and $4 a cubic yard for excavation is about the average, and will include, when work is carried on continuously, the cost of superintending, watching the fleet, etc. While, therefore, the estimates are given for each shoal, they may be greatly modified in practice and serve merely as a basis of comparison of the work to be done at the different obstructions. Of course any shutting down of work will greatly increase this cost.

### DETAILED IMPROVEMENT OF SHOALS.

In these estimates the width at the top of check dams is taken at 10 feet, and of longitudinal dams at 8 feet, with slopes of 1 on 1. An approximate probable location of the dams is assumed and the contents calculated.

*Goose Neck Shoal.*—No improvement is needed at present. In a few years dredging may become necessary.

*McNutt Shoal.*—The points of the reefs should be blasted and check dams built to prolong fall and hold up water on bar.

| | |
|---|---|
| Dams, 1,000 cubic yards | $2,000 |
| Excavation, 400 cubic yards | 1,600 |
| | 3,600 |

*Baker Shoals.*—All the water should be carried over to the left chute by dams and the fall caught up below the present dam. Some dredging and blasting may be necessary.

| | |
|---|---|
| Dams, 3,000 cubic yards | $6,000 |
| Dredging and blasting | 1,000 |
| | 7,000 |

*Knoxville Shoals.*—The leaky dams should be calked, the old bridge piers removed, the channel narrowed and carried over towards the wharf by check dams from the islands, and rock blasted from the channel.

| | |
|---|---|
| Dams, 3,000 cubic yards | $6,000 |
| Excavation, 500 cubic yards | 2,000 |
| | 8,000 |

*Looney Shoals.*—The right chute should be closed, and some dredging and blasting done. There is a bar above the island that may need improvement. This is not a very serious obstruction, and therefore will be among the last to be worked on; in the mean time the action of the gravel should be observed. A few short dams may prove necessary.

| | |
|---|---|
| Dams, 1,000 cubic yards | $2,000 |

*Lyons Shoals.*—The dams already built should be tightened, check dams built, rocks excavated, bowlders removed, bank protected, etc. The improvement will begin from above the islands to 1,000 feet below.

| | |
|---|---|
| Dams, 10,000 cubic yards | $20,000 |
| Bank protection, 2,000 cubic yards | 4,000 |
| Excavation | 2,000 |
| | 26,000 |

*Williams Shoals.*—From present indications the right chute should be closed and the water sent down to left of islands. Dams will be necessary to give sufficient depth for some distance below islands.

| | |
|---|---|
| Dams, 7,000 cubic yards | $14,000 |
| Excavation and dredging | 6,000 |
| | 20,000 |

*Little River Shoals.*—This will be a very difficult shoal to improve. The work will have to begin at the bar above the islands and carried some distance below them. It may be necessary to blast out the upper reef for a foot or more of depth. The check dam below the chute should be removed and the fall carried down by dams. The best plan would seem to be to contract the channel first above, and gradually to work downstream, observing the results.

| | |
|---|---|
| Dams, 10,000 cubic yards | $20,000 |
| Riprap, 2,500 cubic yards | 5,000 |
| Excavation, 750 cubic yards | 3,000 |
| | 28,000 |

*Post Oak Shoals.*—The right channel should be closed and the bars overcome by check dams.

| | |
|---|---|
| 1,500 cubic yards | $3,000 |

*Prater Shoals.*—The channel should be contracted by dams.

| | |
|---|---|
| 1,000 cubic yards | $2,000 |

*Russell Shoals.*—The right chute should be closed and check dams built to near foot of island for the upper bars. At the lower bar the channel should be contracted.

| | |
|---|---|
| Dams, 6,000 cubic yards | $12,000 |
| Dredging | 1,000 |
| | 13,000 |

*Concord Shoals.*—These can be improved by blasting reefs and by the use of dams.

| | |
|---|---|
| Dams, 5,000 cubic yards | $10,000 |
| Excavation, 500 cubic yards | 2,000 |
| | 12,000 |

*Chota Shoals.*—The upper part can be improved by dams and dredging; the lower by carrying the fall to deep water and blasting out bad reefs.

| | |
|---|---|
| Dams, 8,000 cubic yards | $16,000 |
| Blasting, 750 cubic yards | 3,000 |
| Dredging | 1,000 |
| | 20,000 |

*Coulter Shoals.*—The channel will have to be narrowed by check dams and cleared for a mile of length.

| | |
|---|---|
| Dams, 8,000 cubic yards | $16,000 |
| Blasting, 500 cubic yards | 2,000 |
| | 18,000 |

*Sister Islands Shoals.*—These are difficult shoals to improve on account of width of river, circuitousness of channel, and many rocks and reefs. The improvement will have to be effected by confining water and clearing out reefs.

| | |
|---|---|
| Dams, 6,000 cubic yards | $12,000 |
| Blasting, 1,000 cubic yards | 4,000 |
| | 16,000 |

*Bussell Shoal.*—This is similar to Sister Islands Shoals.

| | |
|---|---|
| Dams, 6,000 cubic yards | $12,000 |

*Belle Canton Shoals.*—The water should be thrown into right chute, and perhaps one or two dams built.

| | |
|---|---|
| Dams, 2,000 cubic yards | $4,000 |

*Lenoir Shoals.*—The channel to the left of small island can be improved to a 3-foot depth by dams below its foot. This will never be a very satisfactory channel, and it would be better to obtain a good channel to the right by dams and excavation.

| | |
|---|---|
| Dams, 3,500 cubic yards | $7,000 |
| Excavation, 250 cubic yards | 1,000 |
| | 8,000 |

*Browder Shoals:*

| | |
|---|---|
| Dams, 2,000 cubic yards | $4,000 |
| Excavation, 250 cubic yards | 1,000 |
| | 5,000 |

*Rock Quarry Shoals:*

| | |
|---|---|
| Dams, 500 cubic yards | $1,000 |
| Excavation, 500 cubic yards | 2,000 |
| | 3,000 |

*Winding Shoals.*—The channel follows here the shortest line through the shoals along the convex bank. It can be improved by dams.

| | |
|---|---|
| Dams, 2,000 cubic yards | $4,000 |

A more satisfactory permanent channel, though much more difficult to obtain, would be one on the left or concave bank. The necessary work would consist of—

| | |
|---|---|
| Dams, 5,000 cubic yards | $10,000 |
| Excavation, 1,000 cubic yards | 4,000 |
| Dredging | 1,000 |
| | 15,000 |

*Loudon Shoals.*—The right channel should be closed, the reefs blasted, the channel confined and the fall prolonged by dams.

| | |
|---|---|
| Dams, 6,000 cubic yards | $12,000 |
| Excavation, 1,000 cubic yards | 4,000 |
| | 16,000 |

*Sweetwater Shoals.*—The water should all be thrown to the left and the fall prolonged to below the islands.

| | |
|---|---|
| Dams, 5,000 cubic yards | $10,000 |
| Dredging | 1,000 |
| | 11,000 |

It may in the future prove better to make the channel to the right of island.

Between Sweetwater and Bogart Shoals some blasting will be necessary.

| | |
|---|---|
| Excavation, 250 cubic yards | $1,000 |

*Bogart Shoals.*—All the water should be thrown to the right of island and the fall prolonged to deep water.

| | |
|---|---|
| Dams, 4,000 cubic yards | $8,000 |
| Excavation, 500 cubic yards | 2,000 |
| | 10,000 |

*Bacon Shoals:*

| | |
|---|---|
| Dams, 2,000 cubic yards | $4,000 |

*Wilson Shoals:*

| | |
|---|---|
| Dams, 3,000 cubic yards | $6,000 |
| Excavation, 500 cubic yards | 2,000 |
| | 8,000 |

*Seven Island Shoals.*—More water should be thrown into chute, both above and between the islands. At Farmer Bar dams will have to be built and the fall prolonged to deep water.

| | |
|---|---|
| Dams, 4,000 cubic yards | $8,000 |
| Excavation, 250 cubic yards | 1,000 |
| | 9,000 |

*Long Islands Shoals.*—All the water should be thrown into chute and the bars improved by check dams.

| | |
|---|---|
| Dams, 5,000 cubic yards | $10,000 |
| Dredging and excavating | 2,000 |
| | 12,000 |

*Caney Creek Shoals.*—These shoals will demand a large expenditure to obtain 3 feet. The best way would seem to be to throw all the water to the right bank and check it up by dams, blasting out the reefs where necessary.

The estimate from head of shoals to foot of islands would be—

| | |
|---|---|
| Dams, 7,000 cubic yards | $14,000 |
| Bank protection, 1,500 cubic yards | 3,000 |
| Reefs, 1,500 cubic yards | 6,000 |
| | 23,000 |

The stretch from foot of Caney Island to Turner Bar is a difficult part of the river to improve. As the river is very wide, check dams would be very costly. Dams at two or three of the shallowest places, padding up Turner and other reefs and blasting, seem the best solution.

| | |
|---|---|
| Dams, 6,000 cubic yards | $12,000 |
| Excavation, 1,500 cubic yards | 6,000 |
| | 18,000 |

*Below Turner Reef.*—Some excavation and dams will be necessary.

| | |
|---|---|
| Dams, 2,000 cubic yards | $4,000 |
| Excavation, 1,000 cubic yards | 4,000 |
| | 8,000 |

*Pickles Bar:*

| | |
|---|---|
| Dredging | $1,000 |

*Shields Dam.*—The dam will have to be extended and check dams built below.

| | |
|---|---|
| Dams, 2,000 cubic yards | $4,000 |

*King Bar:*

| | |
|---|---|
| Dams, 2,000 cubic yards | $4,000 |
| Dredging | 1,000 |
| | 5,000 |

*Brackett Bar:*

| | |
|---|---|
| Dams, 1,000 cubic yards | $2,000 |
| Dredging | 1,000 |
| | 3,000 |

*Half Moon Shoals.*—The right chute should be closed, short check dams built at the bars, and the reefs blasted, especially below the island.

| | |
|---|---|
| Dams, 4,000 cubic yards | $8,000 |
| Excavation, 1,500 cubic yards | 6,000 |
| Riprap, 1,500 cubic yards | 3,000 |
| | 17,000 |

*White Creek Shoals.*—More water should be thrown into chute, the dams prolonged, new check dams built.

| | |
|---|---|
| Dams, 7,000 cubic yards | $14,000 |
| Excavation, 500 cubic yards | 2,000 |
| Riprap, 1,500 cubic yards | 3,000 |
| | 19,000 |

*Gillespie Shoals:*

| | |
|---|---|
| Dams, 2,000 cubic yards | $4,000 |
| Dredging | 1,000 |
| | 5,000 |

*Watts Bar.*—The dams should be prolonged, check dams built, and rock blasted.

| | |
|---|---|
| Dams, 10,000 cubic yards | $20,000 |
| Excavation, 1,500 cubic yards | 6,000 |
| | 26,000 |

*Hunter Shoals:*

| | |
|---|---|
| Dams, 1,000 cubic yards | $2,000 |

*Washington Shoals:*

| | |
|---|---|
| Dams, 8,000 cubic yards | $16,000 |
| Excavation, 500 cubic yards | 2,000 |
| | 18,000 |

*Hazleridge Shoals:*

| | |
|---|---|
| Dams, 8,000 cubic yards | $16,000 |
| Excavation, 500 cubic yards | 2,000 |
| | 18,000 |

*Goodfield Shoals:*

| | |
|---|---|
| Dams, 5,000 cubic yards | $10,000 |

*Kelly Shoals.*—The dams should be prolonged and check dams built.

| | |
|---|---|
| Dams, 2,500 cubic yards | $5,000 |
| Excavation and dredging | 2,000 |
| | 7,000 |

*Hiwassee Shoals.*—A check dam is needed at lower end of upper and of main island.

| | |
|---|---|
| Dams, 2,000 cubic yards | $4,000 |

*Sale Creek Shoals.*—Water should be thrown into channel, the islands connected and reefs blasted, or perhaps water turned in above, and some between the islands.

| | |
|---|---|
| Dams, 10,000 cubic yards | $20,000 |
| Excavation, 500 cubic yards | 2,000 |
| Dredging | 2,000 |
| | 24,000 |

*Cross Bar:*

| | |
|---|---|
| Dams, 2,000 cubic yards | $4,000 |

*Soddy Shoals.*—Water will have to be collected above and below the islands, the dams calked and prolonged, the fall carried down, and the reefs removed.

| | |
|---|---|
| Dams, 10,000 cubic yards | $20,000 |
| Excavation, 1,000 cubic yards | 4,000 |
| | 24,000 |

*Dallas Shoals.*—Check dams should be built at head and foot and below island, and if necessary the right chute cut off.

| | |
|---|---|
| Dams, 3,000 cubic yards | $6,000 |
| Dredging | 1,000 |
| | 7,000 |

*Harrison Bar and below:*

| | |
|---|---|
| Dams, 500 cubic yards | $1,000 |
| Excavation, 150 cubic yards | 600 |
| | 1,600 |

*Layman Bar:*

| | |
|---|---|
| Dams, 1,200 cubic yards | $2,400 |

*North Chickamauga Shoals.*—The chute between the islands should be closed, and if necessary the left-hand chute. A series of check dams must then be built to deep water.

| | |
|---|---|
| Dams, 3,000 cubic yards | $6,000 |
| Dredging, 1,000 cubic yards | 1,000 |
| | 7,000 |

*Colwell Bar.*—It seems best to-day to keep the channel to the right by a series of dams down to deep water, and then dredge the bar.

| | |
|---|---|
| Dams, 4,000 cubic yards | $8,000 |
| Dredging and blasting | 2,000 |
| | 10,000 |

*Citico Bar:*

| | |
|---|---|
| Dams, 2,000 cubic yards | $4,000 |

*Chattanooga Shoals.*—More water should be thrown into right chute and the fall carried down.

| | |
|---|---|
| Dams, 2,000 cubic yards | $4,000 |
| Total estimate | $572,600 |

In this estimate only that bank protection is considered that is evidently necessary. It seems probable that a large extent of the bank will eventually have to be protected, snags removed, and overhanging trees cut, thus bringing the total to $600,000.

The following recommendations are made: That $60,000 be appropriated yearly or $120,000 biennially until the 3-foot channel is obtained, and then $10,000 to $15,000 yearly for maintenance.

Work should be done at Soddy Shoals, then in about the order given at Caney Creek, Hazleridge Shoals, Kelly Dam, Watts Bar, White Creek, and Half Moon Shoals below the mouth of the Clinch River, and at Farmer Bar, Bogart, Sweetwater, and Wilson Shoals above. Subsequent work would depend on the changes of the river and the development of commerce.

In carrying out the survey the capable, the conscientious, willing, and persistent work of Mr. J. L. Van Ornum, assistant engineer, both in field and office, and the important services of Mr. John Henson, the pilot, from whom were obtained the location of the channel and a large amount of valuable and accurate information, are deserving of especial mention.

Very respectfully, your obedient servant,

John Biddle,
*Captain of Engineers.*

Lieut. Col. Henry M. Robert,
*Corps of Engineers.*

## V.—TABLES.

### 1. *Table of shoals and depths.*

This table includes all shoals where the depth is less than 5 feet. The figures given in the columns show in feet the stretches of river at the different shoals where depth is less than at head of column.

ABOVE CLINCH RIVER.

[Distance from head of river to mouth of Clinch River, 84.3 miles.]

| | 5 feet. | 4 feet. | 3 feet. | 2 feet. |
|---|---|---|---|---|
| Goose Neck Shoals | 2,000 | 1,300 | 900 | ........ |
| McNutt Shoals | | | | |
| Baker Shoals | 1,400 | 1,100 | 1,000 | 300 |
| Knoxville Shoals | 2,500 | 2,400 | 2,000 | 200 |
| Looney Shoals | 3,400 | 3,300 | 800 | ........ |
| Lyons Shoals | 6,500 | 6,200 | 4,800 | 2,000 |
| Williams Shoals | 9,500 | 9,000 | 6,000 | 2,800 |
| Little River Shoals | 7,000 | 5,000 | 4,000 | 700 |
| Post Oak Shoals | 5,300 | 5,000 | 3,200 | ........ |
| Louisville Bar | 600 | 500 | 300 | ........ |
| Prater Bar | 900 | 500 | 300 | ........ |
| Cox Bar | 4,000 | 2,800 | 2,600 | 700 |
| Russell Shoals | | | | |
| Concord Shoals | 9,500 | 7,000 | 4,000 | 2,000 |
| Chota Shoals | 8,000 | 7,900 | 3,000 | 500 |
| Coulter Shoals | 7,500 | 7,200 | 5,500 | 600 |
| Sister Island Shoals | 9,200 | 8,500 | 7,200 | 150 |
| Bussell Shoals | | | | |
| Belle Canton Shoals | 5,200 | 4,200 | 3,200 | 200 |
| Lenoir Shoals | 1,300 | 1,200 | 400 | 100 |
| Browder Shoals | 1,200 | 1,000 | 800 | 200 |
| Rock Quarry Bar | 1,000 | 950 | 800 | ........ |
| Carmichael Shoals | 700 | 400 | ........ | ........ |
| Winding Shoals | 1,500 | 1,400 | 900 | ........ |
| Loudon Bar | 4,000 | 2,000 | 400 | ........ |
| Harrison Towhead | 200 | ........ | ........ | ........ |
| Sweetwater Shoals | 5,000 | 3,500 | 1,500 | 800 |
| Bogart Shoals | 5,000 | 4,000 | 3,500 | 1,200 |
| Bacon Shoals | 3,300 | 3,200 | 800 | 300 |
| Wilson Shoals | 2,600 | 2,300 | 1,500 | 300 |
| Seven Islands Shoals | 5,400 | 4,700 | 4,000 | 200 |
| Long Island | 10,000 | 5,000 | 1,600 | 500 |
| Total feet | 123,700 | 101,550 | 65,000 | 13,750 |
| Total miles | 23.4 | 19.2 | 12.3 | 2.6 |
| Per cent of distance | 28 | 23 | 15 | 3.1 |

### 1. *Table of shoals and depths*—Continued.

BELOW CLINCH RIVER.

[Distance from mouth of Clinch River to Chattanooga, 103.7 miles.]

| | 5 feet. | 4 feet. | 3 feet. | 2 feet. |
|---|---|---|---|---|
| Caney Creek Shoals<br>Turner Bar<br>Pickles Bar<br>Shields Dam | 28,000 | 21,000 | 9,100 | 1,600 |
| King Bar | 5,000 | 3,500 | 1,800 | 500 |
| Brackett Bar | 4,000 | 3,700 | 2,800 | 900 |
| Half Moon Shoals | 25,000 | 16,000 | 6,000 | ........ |
| White Creek Shoals | 9,000 | 7,000 | 4,800 | 500 |
| Gillespie Bar | 1,800 | 1,500 | 1,300 | 400 |
| At Fouchee and Piney Islands | 400 | ........ | ........ | ........ |
| Watts Bar | 11,500 | 8,500 | 3,000 | ........ |
| Hunter Shoals | 5,000 | 3,200 | 500 | ........ |
| Washington Shoals<br>Hazleridge Shoals<br>Goodfield Shoals | 24,500 | 20,000 | 15,500 | 6,000 |
| Kelly Dam | 9,000 | 7,500 | 2,200 | ........ |
| Martin Bar | 3,000 | 2,000 | 400 | ........ |
| Chatton Bar | 5,000 | 1,000 | ........ | ........ |
| Hiwassee Shoals | 12,000 | 3,200 | 1,000 | ........ |
| Sale Shoals | 16,000 | 14,000 | 6,500 | ........ |
| Thatcher Bar | 5,000 | 4,100 | ........ | ........ |
| Eldridge Bar | 1,700 | ........ | ........ | ........ |
| Soddy Shoals | 19,500 | 11,000 | 5,500 | 2,500 |
| Dallas Shoals | 9,000 | 5,000 | 2,500 | 500 |
| Harrison Bar | 1,500 | 1,400 | ........ | ........ |
| Layman Bar | 1,800 | 1,000 | 300 | ........ |
| Shoemaker Bar | 1,400 | 400 | ........ | ........ |
| Chickamauga Shoals | 5,000 | 2,500 | 1,500 | 200 |
| Colwell Bar | 5,500 | 4,500 | 2,200 | 300 |
| Crutchfield Bar | 2,700 | 700 | ........ | ........ |
| Citico Bar | 1,600 | 1,500 | 1,100 | ........ |
| Chattanooga Shoals | 5,400 | 3,000 | 1,300 | ........ |
| Total feet | 219,300 | 147,200 | 69,300 | 13,400 |
| Total miles | 41.5 | 27.9 | 18.1 | 2.5 |
| Per cent of distance | 40 | 27 | 13 | 2.4 |
| Total from head to Chattanooga (miles) | 64.9 | 47.1 | 25.4 | 5.1 |
| Distance from head to Chattanooga, 188 miles. | | | | |
| Per cent of total distance | 35 | 24 | 14 | 2.7 |

### 2. *Table of distances on Tennessee River from junction of French Broad and Holston rivers to Chattanooga, Tenn., measured along low-water channel.*

[In pools the distances are taken along a line from 200 to 300 feet out from convex bank.]

| | Intermediate. | Total. |
|---|---|---|
| From junction of French Broad and Holston rivers to— | *Feet.* | *Miles.* |
| Head Dickinson Island | 5,250 | 1.0 |
| Foot Dickinson Island | 8,850 | ........ |
| Baker Shoals | 2,300 | 3.0 |
| Knoxville County Bridge | 7,550 | 4.4 |
| Knoxville Railroad Bridge | 2,100 | 4.8 |
| Head Looney Islands | 19,700 | 8.6 |
| Foot Looney Islands | 4,050 | ........ |
| Head Lyons Islands | 13,650 | 11.9 |
| Foot Lyons Islands | 4,500 | ........ |
| Head Williams Islands | 4,100 | 13.5 |
| Foot Williams Islands | 4,800 | ........ |
| Mouth of Little River | 10,950 | 16.5 |
| Head Post Oak Islands | 18,650 | 20.1 |
| Foot Post Oak Islands | 8,400 | ........ |
| Bonds Ferry | 18,800 | 25.2 |
| Louisville | 9,100 | 26.9 |
| Head Prater Island | 8,450 | 28.5 |
| Foot Prater Island | 5,450 | ........ |
| Head Cox Island | 5,000 | 30.5 |
| Foot Cox Island | 3,000 | ........ |
| Head Rogers Islands | 12,550 | 33.5 |
| Concord Landing | 7,900 | 35.0 |
| Foot Rogers Islands | 2,550 | ........ |
| Taliaferro Island | 8,450 | 37.1 |
| Prater Ferry | 2,950 | 37.6 |

2. *Table of distances on Tennessee River, etc.*—Continued.

| | Intermediate. | Total. |
|---|---|---|
| From junction of French Broad and Holston rivers to— | *Feet.* | *Miles.* |
| Head Chota Islands | 8,350 | 39.2 |
| Foot Chota Islands | 5,400 | ........ |
| Parks Ferry | 9,400 | 42.0 |
| Head Coulter Islands | 3,350 | 42.6 |
| Foot Coulter Islands | 6,300 | ........ |
| Leepers Ferry | 8,500 | 45.4 |
| Head Sister Islands | 5,150 | 46.4 |
| Foot Sister Islands | 2,700 | ........ |
| Head Belle Canton Islands | 12,400 | 49.2 |
| Foot Belle Canton Islands | 4,400 | ........ |
| Lenoir City Landing | 3,800 | 50.8 |
| Halls Ferry | 4,200 | 51.6 |
| Browder Island | 17,000 | 54.8 |
| Rock Quarry Shoals | 11,500 | 57.0 |
| Head Carmichael Island | 3,150 | 57.6 |
| Foot Carmichael Island | 4,800 | ........ |
| Winding Shoals | 5,700 | 59.6 |
| Head Blair Islands | 5,450 | 60.6 |
| Loudon Railroad Bridge | 1,200 | 60.8 |
| Foot Blair Islands | 5,500 | ........ |
| County Ferry | 6,100 | 63.0 |
| Harrison Island | 4,000 | 63.8 |
| Huffs Ferry | 7,100 | 65.2 |
| Head Sweetwater Island | 11,800 | 67.4 |
| Foot Sweetwater Island | 2,850 | ........ |
| Head Bogart Islands | 2,700 | 68.4 |
| Foot Bogart Islands | 4,950 | ........ |
| Bacon Shoals | 8,050 | 70.9 |
| Pond Creek | 7,700 | 72.3 |
| Head Wilson Islands | 11,800 | 74.6 |
| Foot Wilson Islands | 5,550 | ........ |
| Paint Rock Ferry | 3,400 | 76.3 |
| Head Seven Islands | 1,300 | 76.5 |
| Foot Seven Islands | 9,650 | ........ |
| Head Long Islands | 4,350 | 79.1 |
| Foot Long Islands | 17,900 | ........ |
| James Ferry | 600 | 82.7 |
| Clinch River | 8,700 | 84.3 |
| Hoods Landing | 17,700 | 87.7 |
| Head Caney Creek Dams | 5,750 | ........ |
| Caney Creek | 5,500 | 89.8 |
| Turner Bar | 8,400 | 91.4 |
| Pickles Landing | 5,350 | ........ |
| Shields Dam | 8,900 | 94.1 |
| Tom Hoods Landing | 650 | ........ |
| Johnsons Landing | 5,000 | ........ |
| Old Ironton | 2,350 | ........ |
| King Bar | 11,150 | 97.7 |
| Rockwood | 7,500 | 99.1 |
| Brackett Bar | 5,050 | 100.1 |
| Head Half Moon Island | 6,250 | 101.3 |
| Head Main Half Moon Island | 2,350 | ........ |
| Ironton | 6,050 | ........ |
| Crescent Mine | 12,750 | 105.3 |
| Foot Half Moon Island | 5,650 | 106.4 |
| Jacksons Ferry | 3,400 | ........ |
| White Creek | 1,500 | ........ |
| Head White Creek Islands | 8,500 | ........ |
| White Creek Landing | 4,850 | 108.9 |
| Red Cloud | 5,150 | 109.9 |
| Gillespie Bar | 10,400 | ........ |
| Euchee | 1,500 | 112.1 |
| Wans Landing | 7,800 | ........ |
| Gillespie Point | 3,000 | 114.2 |
| Head Preston Island | 4,000 | ........ |
| Foot Preston Island | 4,000 | ........ |
| Lucknow | 3,350 | 116.3 |
| Bradys Landing | 5,650 | ........ |
| Head Fouchee Island | 2.100 | 117.7 |
| Foot Fouchee Island | 5,650 | ........ |
| Head Piney Island | 3,750 | 119.6 |
| Foot Piney Island | 7,000 | ........ |
| Pinhook | 1,650 | 121.2 |
| Burke & Browns Landing | 2,350 | ........ |
| Head Watts Island | 2,350 | 122.1 |
| Foot Watts Island | 3,150 | ........ |
| Bankstons Landing | 11,350 | ........ |
| Cooks Landing | 4,350 | ........ |
| Sewee Creek | 10,000 | 127.5 |
| Breedenton | 7,150 | 128.9 |

2. *Table of distances on Tennessee River, etc.*—Continued.

| | Intermediate. | Total. |
|---|---|---|
| From junction of French Broad and Holston rivers to— | *Feet.* | *Miles.* |
| Head Hunter Island | 10,000 | |
| Foot Hunter Island | 2,400 | |
| McPhersons Landing | 400 | |
| Clear Creek | 7,000 | |
| Washington Ferry | 7,650 | 134.1 |
| Lockes Landing | 5,150 | 135.1 |
| Jones Landing | 10,450 | |
| Goodfield Creek | 2,250 | |
| Cottonport | 8,150 | 139.1 |
| Gillespie Landing | 6,400 | |
| Kelly Dam | 5,150 | 141.1 |
| Martin Landing | 3,800 | |
| Chatton Shoals | 13,150 | 144.4 |
| Dayton Landing | 16,950 | 147.7 |
| Armstrongs Ferry | 3,650 | |
| Garrison Ferry | 5,650 | 149.4 |
| Head Hiwassee Island | 5,350 | |
| Hiwassee Ferry | 7,250 | |
| Blythes Ferry | 4,400 | 152.6 |
| Doughty Ferry | 13,000 | 155.1 |
| Head Upper Sale Creek Island | 5,350 | |
| Foot Upper Sale Creek Island | 4,100 | |
| Sale Creek | 2,650 | 157.4 |
| Head Lower Sale Creek Island | 1,000 | |
| Foot Lower Sale Creek Island | 2,650 | |
| Cross Bar | 1,500 | 158.4 |
| Thatcher Bar | 12,550 | 160.8 |
| Eldridge Bar | 2,150 | 161.2 |
| Opossum Creek | 6,600 | 162.5 |
| Upper Dam, Soddy Creek | 6,150 | |
| Head Soddy Islands | 900 | |
| Soddy Creek | 4,500 | 164.7 |
| Foot Soddy Islands | 1,350 | |
| Foot Long Dam | 3,300 | |
| Foot Last Dam | 850 | |
| Blue Spring, Igous Ferry | 13,150 | 168.2 |
| Gans Bluff | 12,650 | 170.6 |
| Head Dallas Island | 5,950 | 171.7 |
| Foot Dallas Island | 7,000 | |
| Ooltewah Creek | 2,950 | 173.6 |
| Harrison Ferry | 1,650 | |
| Harrison Creek | 5,250 | 174.9 |
| Layman Bar | 13,150 | 177.4 |
| Shoemaker Bar | 8,300 | 179.0 |
| Smith Spring | 3,500 | |
| Head Chickamauga Island | 3,250 | |
| North Chickamauga Creek | 4,650 | 181.1 |
| Foot Chickamauga Island | 650 | |
| Cincinnati Southern Railroad Bridge | 1,750 | 181.6 |
| South Chickamauga Creek | 12,000 | 184.0 |
| Crutchfield Bar | 4,550 | 184.9 |
| Citico Bar | 8,650 | |
| Waterworks | 2,050 | |
| Head Chattanooga Island | 1,650 | 187.2 |
| Foot Chattanooga Island | 3,350 | |
| Chattanooga Bridge | 650 | 188.0 |

### 3. *Table of elevations.*

[Assumed elevation, 0 of Chattanooga gauge, 630.64 above sea level.]

| Points. | Elevations above sea level. | Distances between intermediate points. | Fall per mile. | Total fall from junction of rivers. |
|---|---|---|---|---|
| | *Feet.* | *Miles.* | *Feet.* | *Feet.* |
| Low water at junction of rivers | 810.3 | | | |
| 0 Knoxville gauge | 806.6 | 4.4 | 0.84 | 3.7 |
| 0 Loudon gauge | 737.0 | 56.4 | 1.2 | 73.3 |
| 0 Kingston gauge | 712.8 | 23.5 | 1.1 | 97.6 |
| 0 Rockwood gauge | 699.7 | 14.8 | 0.88 | 110.6 |
| 0 Chattanooga gauge | 630.64 | 88.9 | 0.78 | 179.7 |
| Bench mark at Sixth and Market streets, Chattanooga | 684.02 | | | |

| | | |
|---|---|---|
| Total distance from junction of French Broad and Holston rivers to Chattanooga | miles | 188.0 |
| Total fall | feet | 179.7 |
| Fall per mile | do | 0.95 |

### 4. *Table of high water.*

This table gives the height of high water at the two highest floods recorded, 1867 and 1875. The points reached by the water were usually marked on trees and buildings by the inhabitants along the banks and these marks were connected with low water by the level.

| Place. | Height. |  | Authority. | Remarks. |
|---|---|---|---|---|
|  | 1867. | 1875. |  |  |
|  | *Feet.* | *Feet.* |  |  |
| Junction of rivers | 47.5 | 45.5 | Mr. Thos. C. Brabson | Water mark on wall, 7.9 feet and 5.9 feet above X mark on stone of step. |
| Simpsons Ferry |  | 47.0 | Mr. Simpson | Mark on house. |
| Knoxville gauge |  | 39.0 | U. S. Signal Service |  |
| 5 miles below Knoxville. | 42.0 |  |  | Mark on stake driven in surface of ground and in a tree below house of Mr. Armstrong, running to river, right bank. |
| 1 mile below Wrights Ferry. | 43.0 |  |  | At place belonging to Mr. J. L. Bowman, left bank. |
| Post Oak Island | 44.0 |  | Mr. George | On post near joint at upper right-hand corner of shed, at upper end of Post Oak Island. |
| Louisville | 43.5 | 42.0 | Mr. Saffle | Northwest corner of warehouse, on coping of wall. |
| Praters Ferry | 49.0 |  | Mr. Key | Mark on bluff on left bank river. |
| Chota Island, upper end. | 36.5 | 35.5 | Mr. F. N. Roe | Notches in house. |
| Parks Ferry | 38.0 |  | Mr. Parke | On walnut tree 1,000 feet below ferry, 150 feet from water. left bank. |
| Leepers Landing | 44.5 | 42.0 | Mr. H. W. Leeper | On stone gatepost of house. |
| 1 mile below Sister Island. | 43.0 |  | Mr. G. W. Harding | Mark on walnut tree, right bank. |
| Lenoir City | 44.0 |  | Mr. Bussell | Plank nailed to poplar tree on left side of road from Lenoir Ferry, 1,500 feet from river, left bank. |
| Loudon gauge | 42.0 | 39.0 | U. S. Signal Service |  |
| Paint Rock | 41.0 |  | Mr. J. H. Billingsly | No definite mark. |
| James Ferry |  | 39.0 |  | Doubtful. |
| Kingston | 42.5 | 38.5 | Mr. C. A. Locke |  |
| Hoods Landing |  | 34.0 | do |  |
| Rockwood Landing | 44.5 | 41.5 | U. S. Signal Service |  |
| Jacksons Ferry | 48.0 |  | Mr. Alonzo East | Right bank, 2,000 feet north of ferry. |
| Do | 48.0 |  | Mr. B. M. Palmer | On small apple tree, 500 feet from water's edge, left bank. |
| Euchee |  | 51.0 | Mr. C. A. Locke |  |
| Fouchee Island | 49.5 | 47.0 |  | At Brady's Ferry, mark on door facing. |
| Pinhook | 47.0 | 43.0 | Mr. Peak | Notches cut in walnut tree in rear of Peak & Hornedy's store; 1867 mark transferred to upper corner of store. |
| Lockes Ferry | 44.5 |  | Mr. C. A. Locke |  |
| Cottonport | 47.0 |  | Mr. W. O. Allen | On house of W. L. River, left bank. |
| Burgess Landing | 46.0 |  | Mr. R. M. Davis | At base of stump, 40 feet in front of Davis's house. |
| Chattanooga | 58.0 | 54.0 | U. S. Signal Service |  |

The heights at and near Chattanooga are increased by the obstruction below, called the "Suck."

The accuracy of a number of these heights seems doubtful. They depend on the memory of the inhabitants, and it is possible that when only one elevation is given the high water of 1867 and that of 1875 may be confounded.

The heights given under the authority of Mr. C. A. Locke are from an examination made by him in 1889, under direction of this office, for the purpose of determining high-water planes.

### 5. *Table of discharges.*

The Tennessee River during the season of 1891 did not reach either an absolute low or high-water stage, so that the discharge of these stages could not be definitely measured.

The following are the results obtained:

| Date. | River. | Location. | Stage of water. | Discharge. |
|---|---|---|---|---|
| 1891. | | | | Cu. ft. |
| May 28 | Tennessee | Above Knoxville | 2.5, Knoxville, rising | 11,150 |
| Oct. 17 | do | do | 0.8, Knoxville, stationary | 3,950 |
| Aug. 1 | do | Below Loudon | 5.[illegible], Loudon, rising rapidly | 25,350 |
| Oct. 23 | do | do | 0.9, Loudon, stationary | 6,650 |
| Oct. 25 | Clinch | 1 mile above mouth | 0.2, Kingston gauge; 0.6 above low water. | 800 |
| Oct. 29 | Hiwassee | do | 0.8, approximately | 1,650 |
| 1892. | | | | |
| Dec. 12 | Tennessee | Soddy Shoals | 2.3, Chattanooga | 13,700 |

Calculated discharge at Chattanooga at 1-foot stage, 10,000.

*Results obtained by Col. D. L. Sublett, assistant engineer, at Chattanooga.*

| Date. | Stage of water. | Discharge. |
|---|---|---|
| | | *Cubic feet.* |
| Nov. 13, 1891 | *3.0 | 17,550 |
| Apr. 11, 1892 | 30.0 | 222,650 |
| Calculated high water of 1867 | 57.5 | 740,350 |
| Calculated low water | | 8,000 to 9,000 |

* Rising.

*6. Table of current velocities on Tennessee River, 1 foot below surface.*

The velocities vary with the stage of water and are greater with a rising than with a falling river. This table shows simply the velocity at several points where it is swiftest:

| Date. | Location. | Stage of water. | Depth. | Velocity. |
|---|---|---|---|---|
| | | | *Feet.* | *Ft. sec.* |
| May 29, 1891 | Goose Neck Shoals | 3.4, Knoxville, rising | 9.5 | 6.6 |
| May 29, 1891 | Baker Shoals | do | 5.0 | 5.0 |
| May 29, 1891 | Knoxville Railroad Bridge | 2.0, Knoxville | 7.0 | 5.9 |
| June 5, 1891 | Lyons Shoal | 2.0, Knoxville, stationary | 4.6 | 5.3 |
| June 18, 1891 | Little River Shoal | 3.6, Knoxville, rising | 7.0 | 8.4 |
| July 7, 1891 | Chota Shoal | 1.2, Knoxville, stationary | 5.4 | 7.4 |
| Aug. 13, 1891 | Farmer Bar | 2.3, Loudon, stationery | 3.7 | 5.3 |
| Aug. 22, 1891 | Shields Dam | 3.0, Kingston, rising | 8.8 | 2.6 |
| Dec. 12, 1892 | Soddy Shoals | 2.3, Chattanooga, rising | 7.0 | 2.3 |
| Nov. 13, 1891 | Chattanooga | 3.0, Chattanooga, rising | | *2.22 |
| Apr. 11, 1892 | do | 30.0 | | 5.52 |
| High water, 1867 | do | 57.5 | | †7.00 |

* Mean velocity. † Calculated.

*7. Description of bench marks.*

The courses given are magnetic. Average variation, 1° 40′ E.

The elevations of the low-water surface are given on the maps.

The sketches* in the text are duplicated at the end, on separate sheets.

*Bench mark 1.*—Elevation lower stone, 858.6. Elevation upper stone, 861.8. Flat marble slab 1 foot square; cross mark and U. S. B. M. cut in, buried 3 feet under ground. Second stone with cross mark placed over, projecting 6 inches 51 feet above low water. Right bank near junction of French Broad and Holston rivers, 360 feet from bank; in woods, 45 feet from edge. Trees blazed with three notches: Oak, S. 67° W. 23 feet; chestnut; N. 57° W. 25 feet; chestnut N. 7 feet.

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* Not reprinted; printed in House Ex. No. 252, Fifty-second Congress, second session.

*Bench mark 2.*—Elevation lower stone, 833.5. Elevation upper stone, 835.6. Same as No. 1, at edge of seldom-used road; 26 feet above low water. Right bank of Holston, back of ferry landing; bank N. 74° E. 55 feet; gate to main road N. 5° E. 100 feet; angle of wood road N. 5° E. 178 feet; walnut to which ferry wire is attached N. 35¼° E. 110 feet.

*Bench mark 3.*—Elevation lower stone, 842,8. Elevation upper stone, 845.5. Same as No. 1, 35 feet above low water. Left bank of Holston River on inside of orchard fence by lane. Bank, S. 89° W. 309 feet; corner of fence N. 3° E. 207 feet; corner of fence S. 2° W. 152 feet; NE. corner of Brabson's house S. 31° W. 220 feet.

*Bench mark 4.*—Elevation lower stone, 902. Elevation upper stone, 905.3. Same as No. 1. Left bank Holston. You follow road from ferry up French Broad River and then take the first turn to the left; go by old carriage house and 125 feet farther to small wooden culvert. The bench mark is then 175 feet to right, up the hill, near a conspicuous dead tree. There is a cow path in front of and one behind bench mark at about 20 feet distance. Woods are open near bench mark, but thick up the hill. Trees blazed: Oak, N. 60° 30′ W. 20 feet; dead tree, S. 86° 30′ W. 41 feet; oak, knotty and scrubby, S. 27° W. 34 feet.

*Bench mark 5.*—Elevation 825.1. Nail driven about 1 foot above ground on elm tree at point near junction of French Broad and Holston rivers, 14.5 feet above low water. Nail is on side away from Holston River. Tree supports ferry rope.

*Bench mark 6.*—Elevation, 815.3. Hole ¾ inch diameter, 5 feet above low water, drilled horizontally in rock. Left bank of French Broad River. Nearly vertical cliff, just above foot of first island above mouth and 1,000 feet below dam at Jumping Moses Shoal. A conspicuous ledge 50 feet long and 15 wide lies 2 or 3 feet above low water, just upstream from bench mark.

*Bench mark 7.*—Elevation, 819.8. Bolt driven to 2 inches of head, 9.75 feet above low water; cross mark cut in rock; U. S. B. M. and arrows painted in red. Left bank at Cave (Spout) Spring, 5,000 feet below junction of rivers. Bench mark is on small ledge 2 by 4 feet, 6 feet lower and 10 feet downstream from outlet of spring. Three feet lower is a ledge 40 feet long and 10 feet wide. Trees blazed with three notches: Sycamore, 6 inches, N. 2° E. 28 feet; locust, 6 inches, S. 15° E. 53 feet; beech, 18 inches, S. 12° 30′ E. 75 feet.

*Bench mark 8.*—Elevation, 814.4. Bolt driven to 1 inch of head, 6 feet above low water; cross mark cut in rock; U. S. B. M. and arrows in red paint. Right bank on projecting rock, 5,000 feet below head of Dickinson Island. Going downstream the bank is open until 50 yards above bench mark. It is the first rock of a high wooded bluff. The rock is very irregular and rough, and projects as a reef into the river, turning somewhat upstream. Trees blazed with 3 notches: Oak, 6 inches, N. 29° W. 45 feet. Situated about 15 feet higher than bench mark.

*Bench mark 9.*—Elevation, 811.8. Bolt driven to 1 inch of head, 3½ feet above low water; cross mark cut in rock; U. S. B. M. and arrows in red paint. On Cow and Calf Rocks at highest point. Near right bank opposite foot of Dickinson Island.

*Bench mark 10.*—Elevation, 860. Stone 18″ by 6″ by 4″, 53 feet above low water; cross mark and U. S. B. M. cut in top, placed in ground and projecting 1 inch. Right bank 800 feet above Simpson's wire ferry and 1,025 feet from river. At corner of fence just east of barn and shed belonging to and east of red-brick house of Miss Betty McCameron, 20 feet inside of public road below junction with the lane.

*Bench mark 11.*—Elevation, 820.5. Same as above, 14 feet above low water. Right bank 800 feet above Simpson's rope ferry, at edge of fringe of trees, 30 feet from water.

*Bench mark 12.*—Elevation, 834.4. Same as above, 27½ feet above low water. Left bank 800 feet above Simpson's Ferry, 84 feet from river. On side of road opposite the river and about 1 foot outside of fence, 50 feet upstream from cross fence. The main road going downstream separates at this point.

*Bench mark 13.*—Elevation, 892.2. Same as above. Left bank 800 feet above Simpsons Ferry, 500 feet from river, on side hill back of and above Mr. Simpson's house. About 10 feet from fence.

*Bench mark 14.*—Elevation, 814.6. Gauge on second pier from right bank of the county bridge at Knoxville, Tenn. Hole drilled behind 8-foot mark is the bench mark. Elevation of zero of gauge, 806.6.

*Bench mark 15.*—Elevation, 815.9. Bolt driven to 2 inches of head, 11 feet above low water; cross mark cut in rock; U. S. B. M. and arrows in red paint. Left bank on rounded projecting rock about 1,500 feet above lower end of Cherokee bluff. Cherokee bluff begins about 1 mile below Knoxville on left bank and extends downstream about 3 miles. About 1,300 feet above lower end and 1,500 feet below cable line across river is a landing used for picnic parties. Immediately upstream is a bluff of light-colored rock, 50 feet high and 300 feet long. About the center, between two larger projecting points, lies a smaller projection, a rounded rock 4 feet across, on which is bench mark. All the rocks are undermined by the water. The bench mark can be reached from below only by a boat.

*Bench mark 16.*—Elevation, 813.8. Bolt driven to 3 inches of head, 9 feet above low water; cross mark cut in rock; U. S. B. M. and arrows in red paint. Right bank on projecting ledge about 3,000 feet above Looney Island. This ledge forms part of a promontory, which is the first one above Looney Island. Fifty feet upstream is a large rock 40 feet high; 200 feet upstream is a spring. The rocks are very irregular; the bench mark is at most projecting point. Trees blazed with three blazes: Ash, 6 inches diameter, N. 64° W. 26 feet; oak, 24 inches diameter, S. 55° W. This latter is directly behind bench mark and 20 feet higher on bluff.

*Bench mark 17.*—Elevation, 809.9. Bolt driven to 2 inches of head, 6 feet above low water; cross mark cut in rock; U. S. B. M. and arrows painted in red. Left bank, on rocky bluff 150 feet below foot of Looney Island. The left bank in this vicinity is a long bluff 150 feet high, with occasional breaks. The bench mark is near the most projecting point. It is on a slanting ledge 1 foot wide, and behind is perpendicular rock 100 feet high. Trees blazed with three notches: Stumpy sycamore, 18 inches, N. 85° W. 48 feet; ash, 6 inches, S. 73° W. 40 feet; detached rock, 3 by 3 by 3 feet, N. 80° W. 52 feet.

*Bench mark 18.*—Elevation, 806.3. Bolt driven to one-half inch of head, 6 feet above low water; cross mark cut in rock; U. S. B. M. and arrows in red paint. Left bank, on flat table rock, 600 feet below foot of upper Lyons Island. A projecting point of rocks 300 or 400 feet long juts out from the left bank. The bench mark is 50 feet below upper edge (a few scattered rocks lie farther upstream). The bench mark is on rock tapering to point 18 inches wide and 12 inches deep, projecting 3 feet over the water. Trees blazed with three notches: Oak, 15 inches, N. 4° W. 34 feet; hickory, 10 inches, N. 43° E. 7 feet; oak, 10 inches, S. 72½° W. 8 feet.

*Bench mark 19.*—Elevation, 799.8. Bolt driven to 1 inch of head, 4 feet above low water; cross mark cut in rock; U. S. B. M. and arrows painted in red. Right bank at foot of overhanging bluff; 1,500 feet above foot of largest of Williams Islands. Behind bench mark is bluff 40 feet high; 20 feet upstream is a rock 3 feet high projecting over water about 2 feet; the rocky projection or bluff ends 20 feet downstream below bench mark. Trees blazed with three notches: Ash, 14 inches, S. 12° 30′ W. 13 feet; elm, 8 inches, S. 9 feet; crooked ash 10 inches, N. 53° W. 12 feet. These trees all lie higher up the bluff than the bench mark.

*Bench mark 20.*—Elevation, 798.9. Bolt driven to 2 inches of head, 4½ feet above low water; cross mark cut in rock; U. S. B. M. and arrows in red paint. Left bank on flat laminated rock 1,000 feet above uppermost dam at Little River Shoals. The rock is one of a clump of flat rocks of various sizes up to 10 by 5 by 3 feet. It is the highest or nearly so of these rocks and lies on a larger one. It is formed of two pieces. Trees blazed with three notches: Inclined whitewood, 14 inches, S. 1° 30′ W. 23 feet; horizontal elm just back of bench mark 12 inches 6 feet; white oak, 18 inches, N. 78° 30′ W. 27 feet.

*Bench mark 21.*—Elevation of bolt, 789.1. Bolt driven to 3 inches of head, 6 feet above low water; cross mark cut in rock; U. S. B. M. and arrows in red paint. Left bank, on ledge of rocky bluff, 1,500 feet above foot of Post Oak Island. On viewing the bluff from river a seam forms a conspicuous curve shaped like a catenary. The bench mark is near the lowest part. The ledge extends 200 feet upstream from bench mark and 15 feet downstream; it is from 2 to 5 feet wide, sloping towards the river. Behind bench mark the rock is 15 feet high perpendicularly. Opposite on island is a tow head grown with young sycamores. Trees blazed with three notches: Elm, 6 inches diameter, N. 16° W. 57 feet; stumpy sycamore, 18 inches diameter, S. 7° W. 25 feet; hickory, 12 inches diameter, S. 22° E. 19 feet.

*Bench mark 22.*—Elevation, 783.5. Bolt driven to one-half inch of head, 7 feet above low water; cross mark cut in rock; U. S. B. M. painted in red. Left bank on large flat rock at Louisville Landing; 11.2 feet above derrick, 13.9 feet below large ring in rock, 15 feet above ferry wire, 20 feet from water at low water.

*Bench mark 23.*—Elevation, 779.6. Bolt driven to 2 inches of head, 4 feet above low water; two arrows cut in stone; U. S. B. M. and arrows painted in red. Right bank on flat rock 200 feet above head of Cox (Russell) Island. Rock is 10 feet long and 6 wide. Two furrows 6 inches wide and 8 inches deep run across rock nearly perpendicular to river. Bench mark is 2 feet from upstream furrow. A laminated rock of about 15° inclination and projecting out in the river, 2 feet high at low water, lies just downstream. The locality is used as a skiff landing. Trees blazed with three notches: Elm, 18 inches, S. 86½° W. 35 feet; maple, 12 inches, N. 78½° W. 11½ feet; maple, forked 2 feet above ground, each fork 8 inches, N. 41° W. 4½ feet; overhanging willow, 8 inches, N. 62° E. 13 feet.

*Bench mark 24.*—Elevation, 772.4. Bolt driven to 1½ inches of head, 3 feet above low water; two arrows cut in rock; U. S. B. M. and arrows painted in red. Right bank, on rocky ledge 300 feet below Concord Landing, opposite point of small island. For 300 feet below landing the woods extend to the water's edge; at the first clear place lies a flat rock 25 feet long and 5 feet wide. Four feet from lower end is the bench mark. Further downstream comes a ledge 6 feet wide, slanting at 45°, on which the U. S. B. M. is painted. Trees blazed with three notches: Sycamore, 8 inches, N. 55° E. 42 feet; elm, 12 inches, N. 41° E. 25 feet; oak, 24 inches, N. 33½° E. 32 feet.

*Bench mark 25.*—Elevation, 789.9. Bolt driven to 1 inch of head, 22 feet above low water; cross mark cut in rock; U. S. B. M. and arrows painted in red. Left bank, on bench of overhanging rock, 1,000 feet below head of upper Chota Island. Two or three hundred feet below point of upper dam begins a bluff about 50 feet high; on the second most conspicuous face of same from upstream edge lies the bench mark. The bluff extends three or four hundred feet farther downstream and terminates in an old quarry used for the dams. The ledge on which bench mark is located is 40 feet long, 4 or 5 broad, and almost covered by overhanging rock. Bench mark is near center of length and 8 inches from edge.

*Bench mark 26.*—Elevation, 761.8. Bolt driven to 2 inches of head, 1½ feet above low water; cross mark cut in rock; U. S. B. M. and arrows in red paint. Right bank on projecting face of rock opposite, 100 feet above lower point of dam at Coulter Shoals. The rock is 25 feet long and 10 feet wide, pointing diagonally downstream and with dip towards river of 20°. The rock lies about the center of a projecting point of rocks 75 feet long and 10 feet high. Trees blazed with three notches: Oak, 12 inches, N. 35° W. 22 feet; ash, 30 inches, S. 3° W. 19 feet.

*Bench mark 27.*—Elevation, 756.9. Bolt driven to 2 inches of head, 3½ feet above low water; cross mark cut in rock; U. S. B. M. and arrows painted in red; left bank on flat table rock 300 feet below upper point of Sister Island. It is on a large detached rock joining on the bank and quite conspicuous. Trees blazed with three notches: Oak, 24 inches, N. 19° 30′ E. 44 feet; ash, 8 inches, N. 46° 30′ E. 29 feet; beech, 15 inches, N. 78° E. 53 feet.

*Bench mark 28.*—Elevation, 748.3. Bolt driven to one-half inch of head, 3 feet above low water; cross mark cut in rock; U. S. B. M. and arrows painted in red. Right bank on conspicuous sloping rock 1,200 feet below foot of Belle Canton Island. The slope of rock is diagonally downstream. Trees blazed with three notches: Ash, 20 inches, N. 24° W. 23½ feet; ash, 8 inches, N. 36° E. 46 feet.

*Bench mark 29.*—Elevation, 747. Bolt driven to one-half inch of head, 4 feet above low water; cross mark cut in rock; U. S. B. M. and arrows painted in red. Left bank, on rock about 100 feet below foot of lowest part of lowest island at mouth of the Little Tennessee River. It is the first, from upstream end, of a group of large bowlders. Lenoir Creek can just be seen below island. The bank in the vicinity is an irregular bluff about 30 feet high. Trees blazed with three notches: Oak, 12 inches, S. 33° E. 21 feet; hickory, 12 inches, S. 16° E. 38 feet.

*Bench mark 30.*—Elevation 745.6. Bolt driven to 2 inches of head, 4 feet above low water; cross mark cut in rock; U. S. B. M. and arrows painted in red. Right bank on sloping face of rock 1,600 feet below Browder Island. Bench mark is on a small ledge 1 foot square, forming part of a large rock 25 feet long, 15 high, sloping toward river at a dip of about 45° and pointing slightly downstream. Trees blazed with three notches: Oak, 6 inches, N. 55° 30′ W. 22 feet; ash, 6 inches, N. 87° 30′ W. 22 feet.

*Bench mark 31.*—Elevation, 749.8. Bolt driven to 3 inches of head, 9½ feet above low water; cross mark cut in rock; U. S. B. M. and arrows in red paint. Right bank, on rock bluff 1,000 feet above Carmichael island (island not visible from bench mark), below foot of Rock Quarry Shoal, 200 feet high and very precipitous and bare. Bench mark is 50 feet from lower end, on sloping ledge, 15 feet long and 12 feet wide with a downstream dip of 15°. Ten feet downstream from bench mark the rock presents a sheer face perpendicular to river about 15 feet deep.

*Bench mark 32.*—Elevation, 744.9. Bolt driven to 2 inches of head, 5 feet above low water; cross mark cut in rock; U. S. B. M. and arrows in red paint. Left bank on bowlder, in direct prolongation downstream of channel behind Carmichael Island. Bowlder is 10 feet by 2 feet, and is very conspicuous from upstream, lying at the foot and at projecting point of a solid rock bluff 150 feet high. Bench mark near point of bowlder. Trees blazed with three notches: Stumpy sycamore, 2 feet, S. 85° E. 28 feet; stumpy sycamore, 1 foot, 11 feet.

*Bench mark 33.*—Elevation, 747.1. Bolt driven to 1½ inches of head, 9 feet above low water; cross mark cut in rock; U. S. B. M. and arrows in red paint. Left bank on round projecting rock 4,500 feet above railroad bridge at Loudon. Rock forms part of prominent projection at foot of Winding Shoals. Bench mark is 100 feet from lower end on principal projecting rock. Rock is 20 by 15 feet; dip upstream of 30° to 2 feet above low water, where it becomes vertical The downstream side is vertical. Bowlder to the rear about 40 feet high. Trees blazed with three notches: Elm, 6 inches, directly in rear 4 feet.

*Bench mark 34.*—Vertical part of river gauge at Loudon railroad bridge. Zero of gauge, 737.

*Bench mark 35.*—Elevation, 741.8. Bolt driven to one-half inch of head, 5 feet above low water; cross mark cut in rock; U. S. B. M. and arrows in red paint, Left bank on inclined front rock 700 feet below railroad bridge at Loudon, Tenn. Rock about 30 feet by 20 feet, and bench mark near center. It has a dip towards far end of railroad bridge of about 45°. The earth above has been washed. Adjoining upstream is a series of thin layer of rock with dip of 25° upstream and presenting vertical faces to the river. Trees blazed with three notches: Oak, 14 inches, S. 80° 30′ W. 50 feet; oak, 8 inches, N. 61° W. 35 feet; cedar, 8 inches, N. 1° 30′ E. 36 feet.

*Bench mark 36.*—Elevation, 786.9. Stone 3 feet long with cross mark and U. S. B. M. set in ground, slightly projecting above ground, 56 feet above low water. Right bank on line with bench mark No. 37, 70 feet from bank, up steep rocky bluff from bench mark 37.

*Bench mark 37.*—Elevation, 737.8. Bolt driven to 1 inch of head, 7 feet above low water; cross marks cut in rock; U. S. B. M. and arrows in red paint. Right bank on projection of bluff, 2,500 feet below Harrison Island and 3,000 feet above Huffs Ferry. This rocky bluff is the only one for a mile each way. Bench mark is near upper end of bluff, on rock projecting diagonally downstream. Trees blazed with three notches: Hickory, 6 inches, S. 35° W. 34 feet.

*Bench mark 38.*—Elevation, 739.3. Stone about 3 feet long, 8.5 feet above low water, with cross mark and U. S. B. M. cut in, set in ground slightly projecting. Left bank in line with bench mark No. 37, in field, 20 feet from river.

*Bench mark 39.*—Elevation, 804.9. Stone about 3 feet long, 74 feet above low water, with cross and U. S. B. M. cut in top, set in ground slightly projecting. Left bank on line with bench mark 37. By side of fence parallel to river and near third rail, downstream from gate; 930 feet from river.

*Bench mark 40.*—Elevation, 735.3. Bolt driven to one-half inch of head, 5 feet above low water; cross mark cut in rock; U. S. B. M. and arrows in red paint. Left bank on small rock about 1,500 feet above Sweetwater Island. Bench mark is about 200 feet upstream from most projecting point of ledge on a rock with a dip of 45° diagonally upstream. Fifteen feet downstream the rock is cut in toward bank, making a vertical face of layers of rock 1 foot thick. Loose bowlders lie at foot of ledge. Trees marked with three notches: Hickory, 15 inches, S. 10° 30′ W. 50 feet; oak, 18 inches, N. 25° W. 57 feet.

*Bench mark 41.*—Elevation 734.9. Stone 3 feet by 6 inches by 6 inches, 9 feet above low water with cross mark and U. S. B. M. cut in, set in ground just projecting out. Right bank about 500 feet above lower point of Bogart Islands near clump of trees, and 25 feet from water. Trees blazed with three notches: Maple, 5 inches 6.7 feet; maple, 7 inches, 4.7 feet; maple, 18 inches, 9.1 feet (level bench mark).

*Bench mark 42.*—Elevation 740.4. Stone about 6 inches square on top, 17 feet above low water, marked U. S. B. M., placed in ground projecting 2 inches. Right bank, 1,000 feet above foot of Bacon Shoals. Bench mark about 60 feet from water, and 1 foot from fence, and 10 feet nearer river than where horizontal rails in fence begin. On upper side of fence is a large brush pile and cleared land. On lower side it is rocky. Trees blazed with three notches: Burr oak, 30 inches back from river 85 feet; hickory, 12 inches downstream; sycamore, diagonally upstream 40 feet.

*Bench mark 43.*—Elevation, 756.8. Bolt driven to 1 inch of head, 35 feet above low water; cross mark cut in rock; U. S. B. M. and arrows painted in red. Right bank on small bowlder, 1,300 feet below upper point of Wilson Island. Bowlder rises 3 feet above ground and is about 6 feet by 3 feet. It lies 20 feet upstream from point of rocks projecting nearly to river's edge. Behind is a vertical rock face 100 feet long and 15 feet high. Bench mark is 60 feet from water's edge and 10 feet back from corner of fence inclosing the foot of a field running upstream. Downstream the land is rocky and woody. Trees blazed with three notches: Hackberry, 18 inches (part of fence), S. 85° W. 50 feet; hackberry, 8 inches (part of fence), S. 31° W. 11 feet; hackberry, 9 inches, N. 2° E. 5½ feet; maple, 15 inches, N. 18° E. 25 feet.

*Bench mark 44.*—Elevation, 723.5. Bolt driven to 1 inch of head, 6 feet above low water; cross mark cut in rock; U. S. B. M. and arrows in red paint. Right bank, on small rock bluff, 1,600 feet above lower point of last of Seven Islands, and 1,200 feet below point of Second Dam, 300 feet above foot of one of the Seven Islands, and 200 feet below where woods commence on same islands, 200 feet below where rocks first begin to show on right bank. The rocks of the bluff are in layers 1 foot thick, with a dip upstream of about 20°; 2 feet upstream from bench mark is an especially conspicuous rock facing diagonally upstream. It is 15 feet long, 10 wide, and 2 thick, of soft limestone with hard black nodules. On hill behind are many small cedars. Trees blazed with three notches: Cedar, 5 inches, N. 54° W. 16 feet; elm, 10 inches N. 90° W. 16 feet; sycamore, 24 inches, just behind.

*Bench mark 45.*—Elevation, 719.7. Bolt driven to inch of head, 6 feet above low water; cross mark cut in rock; U. S. B. M. and arrows in red paint. Right bank on very conspicuous table rock, 7,500 fee[illegible] Long Island. Rock projects conspicuously from rocky shore. It is f[illegible] r 5 inches thick. A stone fence goes up hill from edge of rock. Bench mark is on shelf, 1 foot below highest point of rock, near stone fence.

*Bench mark 46.*—Elevation, 716.0. Bolt driven to 1 inch of head, 3.5 feet above low water; cross mark cut in rock; U. S. B. M. and arrows in red paint. Right bank, near lower end of projecting promontory, 4,500 feet below mouth of Clinch River, and 1,700 feet below mouth of creek. Bench mark 200 feet upstream from lowest part of promontory and 20 feet upstream from most projecting part. It is a ledge with dip to river of 45° for 150 feet up, and 20 feet downstream from bench mark. A sheer rock precipice, 60 to 75 feet high, is 2,000 feet upstream. A conspicuous cedar tree, 30 inches diameter, stands 400 feet upstream and 50 feet higher than river. Trees blazed with three notches: Dead elm, 12 inches, S. 81° W. 21 feet; cedar, 8 inches, N 11° E. 30 feet; cedar, 8 inches, N. 23° 30′ W. 33 feet; cedar 6 inches, N. 58° W. 30 feet.

*Bench mark 47.*—Elevation, 713.4. Bolt driven to 1 inch of head, 3 feet above low water; cross mark cut in rock; U. S. B. M. and arrows in red paint. Left bank, on small rocky cliff, about 50 feet above foot of small island, lying close to left bank, at head of Caney Creek Shoals. The rock has a dip toward the river of 45°. The bench mark is on a flat place only a few inches wide and long. Trees blazed with three notches: Double hickory, 6 inches, S. 8° E. 28 feet; elm, 12 inches, S. 88° W. 6 feet; Oak, 18 inches, N. 71° W. 26 feet.

*Bench mark 48.*—Elevation, 715.3. Stone, 8 inches square, buried to upper face in ground, 9.3 feet above low water; cross mark and U. S. B. M. cut in stone. Right bank opposite pile of rocks in right of channel near left bank at Turner Bar. At a log landing 15 feet from river, 100 feet upstream from two tall sycamores standing alone on river bank, and at lower end of clump of maples and sycamores. It is covered with dirt. Trees blazed with three notches: Sycamore, 8 inches, N. 15° 30′ E. 32 feet; willow, 6 inches, N. 30° E. 18½ feet; maple 12 inches, N. 58° E. 12 feet.

*Bench mark 49.*—Elevation, 716.3. Stone, 6 by 4 inches, sunk to 2 inches of top, 13 feet above low water; U. S. B. M. and cross cut in top. Left bank, 25 feet below lower part of Shields Dam, at upper end of Tom Hood's log landing; 25 feet from river, 10 feet from upper edge of bank toward river and 8 feet lower; 33 feet upstream from clump of maples. Trees blazed with three notches: Clump of maples, with one root, S. 66° 30′ W. 33 feet, each 1 foot diameter; hackberry, 14 inches, S. 21° 30′ W. 5 feet; walnut, 10 inches, N. 76° 30′ E. 3½ feet; hackberry, 6 inches, N. 49° E. 12½ feet.

*Bench mark 50.*—Elevation, 708.8. Bolt driven to 1½ inches of head, 8½ feet above low water; cross mark cut in rock; U. S. B. M. and arrows in red paint. Left bank, at small bluff at lower end of King Bar. Bluff is 60 feet long, 40 feet high, and is the upper one of two rocky projections about 300 feet apart, one-fourth mile below bar proper. Bench mark is on a semidetached rock, 1 foot wide, 2½ long, about one-third way up bluff and one-third way down from upstream end. U. S. B. M. is painted on overhanging face 4 feet high and 10 feet long, 5 or 6 feet over the bench mark.

*Bench mark 51.*—Elevation of zero, 699.7. Gauge at Rockwood Landing.

*Bench mark 52.*—Elevation, 705.4. Bolt driven to 1½ inches of head, 6 feet above low water; cross mark cut in rock; U. S. B. M. and arrows in red paint. Left bank, at highest point of rock, at lower end of bluff, 3,500 feet above first towhead of Half Moon Islands. The bluff is first one on left bank in descending river. It is 200 feet long and rises sheer from river 50 feet. There is an old Government quarry at this point. Bench mark is 15 feet upstream from where loose rocks begin. U. S. B. M. is painted over the bench mark about 15 feet. Trees blazed with three notches: Willow, 8 inches, 26½ feet; sycamore, 9 inches, S. 3° E. 28 feet.

*Bench mark 53.*—Elevation 701.0. Bolt driven to 1 inch of head, 4½ feet above low water; cross mark cut in rock; U. S. B. M. and arrows in red paint. Left bank, on rock at irregular wooded bluff, 50 feet high, 11,000 feet below head of Half Moon Island, and 1,500 feet below Ironton ore docks. Bench mark is on small rounded projection at upper end of vertical part of bluff, which is here about 30 feet high. U. S. B. M. is painted 18 feet over and 15 feet downstream from bench mark. Trees blazed with three notches: Elm, 15 inches, N. 47° E. 17 feet; ash, 12 inches, N. 36° E. 25 feet; sycamore, 10 inches, S. 41° W. 9 feet; stumpy elm, 24 inches, S. 40° 30′ W. 44 feet. This elm is at lower end of bluff.

*Bench mark 54.*—Elevation, 697.3. Bolt driven to 2 inches of head, 7 feet above low water; cross mark cut in rock; U. S. B. M. and arrows in red paint. Right bank, on projecting ledge opposite first towhead at White Creek Shoals. The ledge has a dip downstream of 30°. Bench mark is at a sharp projection of 3 or 4 feet; U. S. B. M. is painted 20 feet downstream. Trees blazed with three notches: Ash, 8 inches, N. 67° W. 33½ feet; oak, 15 inches, S. 33° W. 42 feet.

*Bench mark 55.*—Elevation, 690.0. Bolt driven to 1 inch of head, 6 feet above low water; cross mark cut in rock; U. S. B. M. and arrows in red paint. Left bank, on small ledge at first bluff, about 2,500 feet below Red Cloud ore dock. It is a triangular-shaped ledge, 3 feet on a side, about 25 feet from upper end of bluff. Bench mark is 6 inches from edge. A larger and more pointed ledge lies 5 feet downstream. U. S. B. M. is painted 6 or 7 feet over bench mark. Trees blazed with three notches: Maple, 24 inches, N. 44° E. 60½ feet; elm, 15 inches, N. 82° E. 19 feet.

*Bench mark 56.*—Elevation, 690.9. Bolt driven to one-half inch of head, 8.5 feet above low water; cross mark cut in rock; U. S. B. M. and arrows painted in red. Left bank on small bluff 2,100 feet above upper point of Preston Island. This bluff is 500 feet below high vertical bluff. Bench mark is 20 feet downstream from beginning of bluff, on a sloping face. Five feet underneath bench mark is a ledge 10 feet long and 5 wide. Behind bench mark the rock is steeper and almost bare. Trees blazed with three notches: Birch, 4 inches, 29.5 feet; elm, 30 inches, S. 42° W. 78 feet.

*Bench mark 57.*—Elevation 689.0. Bolt driven to 1 inch of head, 8 feet above low water; cross mark cut in rock; U. S. B. M. and arrows in red paint. Right bank, small sloping rock opposite about middle part of Fonchee Island; 2,500 feet below head of island a rocky promontory juts out, the base of which is loose rocks. Bench mark is 1,200 feet below upper point of same. A rock 4 by 5 by 3 feet at low water stands detached 150 feet below bench mark; 2 large rocks 10 by 5 by 1 feet lie 25 or 30 feet downstream from bench mark. Bench mark is 15 feet from edge of water (at low water) on a rock visible 4 by 1 by 1 feet and prolonged to water by two slightly larger rocks undermined and pointing upstream. Trees blazed with three notches: Hickory, 10 inches, S. 6° W.; beech, 6 inches, S. 49° W. 14 feet; beech, 5 inches, S. 85° W. 25 feet.

*Bench mark 58.*—Elevation, 690.0. Stone 8 inches square sunk even with surface of ground, 9 feet above low water; U. S. B. M. and cross mark cut in stone. Right bank, opposite upper point first island at Watts Bar. 250 feet above upper end of dam in channel, 15 feet from water's edge at low water. Trees blazed with three notches: Sycamore, 24 inches, N. 17° E. 13 feet; sycamore, 30 inches, N. 21° 30′ W. 33 feet; walnut, 8 inches, N. 85° W. 28 feet; walnut, 6 inches, S. 26° 30′ W. 15 feet; oak, 30 inches, S. 15° 30′ W. 49 feet; elm, 20 inches, S. 43° E. 48 feet.

*Bench mark 59.*—Elevation, 683.2. Bolt driven to 1 inch of head, 6½ feet above low water; cross mark cut in rock; U. S. B. M. and arrows in red paint. Right bank, on projecting point, 1,500 feet above Sewee Creek. The point is 30 feet high, very conspicuous, made up of large bowlders. Bench mark is on flat rock 20 feet wide by 10 feet long, 50 feet below upper end of bluff, and the most prominent of the bowlders. It slopes gently to front, a little downstream, with a vertical face at river, and widening somewhat to the rear. Trees blazed with three notches: Maple stump, 8 inches, S. 68° E. 13 feet; sycamore, 10 inches, S. 16° W. 14½ feet.

*Bench mark 60.*—Elevation, 680.2. Bolt driven to 1 inch of head, 5 feet above low water; cross mark cut in rock; U. S. B. M. and arrows in red paint; left bank on bluff 4,000 feet below lower point of Hunter Island. The bluff is formed of a series of shelving rocks with a dip of 10° or 15° upstream. Bench mark is 150 feet downstream from beginning of bluff and 25 feet upstream from most projecting point. The shelf on which is bench mark is 15 feet long and 4 to 5 feet wide. Directly behind is a vertical face 4 feet high and 10 feet long. Upstream 15 feet lies an overhanging rock projecting some 6 or 7 feet.

*Bench mark 61.*—Elevation, 677.9. Bolt driven one-fourth inch of head, 4 feet above low water; cross mark cut in rock; U. S. B. M. and arrows in red paint; right bank, on flat large rock 1,400 feet below Lockes or Robinsons Landing, at head of Hazleridge Shoals; 1,400 feet downstream lies a heavily wooded hill. The rock is 15 by 10 feet with a dip downstream of about 15°. Immediately upstream lies a similar rock. Trees blazed with three notches: Elm, 18 inches, N. 80° 30′ W., 16 feet; oak, 18 inches, N. 86° 30′ W. 30 feet; ash, 8 inches, S. 6° W. 12 feet; elm, 30 inches (group of three), S. 22° E. 25 feet.

*Bench mark 62.*—Elevation, 678.8 Stone monument 12 inches square sunk in ground to within 6 inches of surface, 7½ feet above low water; marked with cross and U. S. B. M.; left bank, 25 feet above Goodfield Creek and same distance from river. Trees blazed with three notches: Birch, 4 inches (group), N. 19° 30′ W. 17.5 feet; elm, 18 inches, N. 90° E. 14.8 feet. Nearest of group of elms S. 32° W. 8.4 feet.

*Bench mark 63.*—Elevation, 672.8. Bolt driven to one-half inch of head, 3 feet above low water; cross mark cut in rock; U. S. B. M. and arrows in red paint. Left bank, on flat rock, 1,500 feet below Cottonport Landing. Rock 7 feet by 8 feet by 3 feet high, with upper surface sloping diagonally upstream, 150 feet below upper end of rocky hill. Trees blazed with three notches: Sycamore, 12 inches, S. 29° W. 25 feet; sycamore, 10 inches, S. 25° 30′ E. 21 feet; oak, 18 inches, S. 22° E. 37 feet.

*Bench mark 64.*—Elevation, 668.5. Bolt driven to three-fourths of an inch of head, 5 feet above low water; cross mark cut in rock; U. S. B. M. and arrows in red paint; left bank on projecting rock 3,000 feet above Dayton Landing. Rock forms part of small bluff. It is 20 feet square, sloping towards river with dip of 25°. Bench mark is 2 feet from edge and about middle of front length. Trees blazed with three notches: Persimmon, 6 inches, N. 86° 30′ W. 20 feet; ironwood, 10 inches, S. 59° W. 42 feet; leaning cedar, 16 inches, S. 43° 30′ W. 41 feet.

*Bench mark 65.*—Elevation, 671.3. Bolt driven to one-half inch of head, 8 feet above low water; cross mark cut in rock; U. S. B. M. and arrows in red paint. Left bank, near upper end of Garrison Bluff, 2,500 feet above Hiwassee Island. Bench mark is on a well-defined ledge 200 feet long and up to 10 feet wide. It is 2 feet from edge and 80 feet from lower end of ledge. Trees blazed with three notches: Elm, 10 inches, N. 40° E. 54 feet; cedar 18 inches, N. 51° E. 40 feet.

*Bench mark 66.*—Elevation, 665. Bolt driven to one-half inch of head, 3½ feet above low water; cross mark cut in rock; U. S. B. M. and arrows in red paint; right bank, on wide flat ledge of rock at upper end of landing of ferry to middle point of Hiwassee Island. The ledge is 200 feet long and 30 wide, sloping gently to river and covered with small rocks. Bench mark is about 50 feet upstream from point where dirt road strikes this ledge and at low water about 15 feet from water. Trees blazed with three notches: Elm (scraggy), 24 inches, N. 6° E. 35 feet; cedar, 12 inches, N. 60° 30′ W. 36 feet; 3 elms (8 inches each), S. 59° 30′ W. 54 feet.

*Bench mark 67.*—Elevation, 666.2. Bolt driven to one-half inch of head, 4 feet above low water; cross mark cut in rock; U. S. B. M. and arrows in red painted 15 feet upstream; right bank, at double bluff, 2 miles below Hiwassee Island, 1,600 feet above Doughty Ferry. On rock 4 by 2 by 4 feet, 500 feet below upper end of bluff, 100 feet above most projecting point. The rock can be reached only by boat. Immediately behind the bluff forms a small triangular recess 15 feet long, 6 feet deep, and 25 feet high. Short sycamore stump grows 10 feet upstream.

*Bench mark 68.*—Elevation, 664.1. Bolt driven to one-quarter inch of head, 5½ feet above low water; cross mark cut in rock; U. S. B. M. and arrows in red paint; left bank, on large bowlder at lower end of bluff opposite Sale Creek, 800 feet above upper part of lower island. The bowlder is double. Bench mark is on part that is larger and farther upstream. Bowlder is about 8 by 5 by 4 feet and lies 400 feet above lower edge of woods. Trees blazed with three notches: Two birches, each 14 inches, N. 71° 30′ E. 17½ feet; ironwood, S. 85° E. 27 feet; sycamore (clump), 48 inches, S. 36° E. 26 feet.

*Bench mark 69.*—Elevation, 657.7. Bolt driven to one-half inch of head, 3½ feet above low water; cross mark cut in rock; U. S. B. M. and arrows in red paint; right bank on horizontal ledge of vertical rock bluff 50 feet high, 1 mile above Soddy Island and 1,200 feet above Opossum Creek. Bench mark on ledge 50 feet long and 5 feet wide, 300 feet from upstream end of bluff. It is not accessible by land from downstream end or from the back, but can be reached from upstream end at low water. Trees blazed with three notches: Sycamore, 2 feet, N. 16° 30′ E. 22 feet.

*Bench mark 70.*—Elevation, 655.9. Bolt driven to one-half inch of head, 4 feet above low water; cross mark cut in rock; U. S. B. M. and arrows in red paint; left bank about center of timbered bluff, 800 feet below upper point of upper Soddy Island. On diamond-shaped bowlder 6 by 9 by 1 feet, the first outlying one below Soddy Shoals Dam, 18 inches from point of bowlder. Immediately over is another bowlder 10 by 6 feet with a dip to the river of 35° on which is painted U. S. B. M. Trees blazed with three notches: Sycamore clump, 48 inches, S. 12° W. 10 feet; maple clump, 24 inches, N. 43° E. 33 feet; ash, 14 inches, N. 81° E. 24 feet.

*Bench mark 71.*—Elevation, 662.4. Stone about 12 by 6 inches sunk to 2 inches of head, 10 feet above low water; cross mark and U. S. B. M. cut in rock; right bank, near mouth of Soddy Creek, on right bank of creek. Trees blazed with three notches: Sycamore, 24 inches, S. 78° E. 10 feet; maple, 12 inches, S. 56° E. 34 feet; double hackberry, 12 inches each, S. 37° E. 29 feet; walnut, 24 inches, N. 72° W. 42 feet; sycamore, 24 inches; N. 12° W. 17 feet; maple 12 inches, N. 33° W. 13 feet.

*Bench mark 72.*—Elevation, 651.3. Bolt driven to 1 inch of head, 4½ feet above low water; cross mark cut in rock; U. S. B. M. and arrows in red paint; left bank, on projection at lower end of Denny Bluff, one-half mile below Blue Springs. Bench mark is on ledge 3 feet wide and 10 feet long, with dip upstream of 10° and lying 150 feet above downstream end of bluff, and 200 feet downstream from vertical part of bluff. U. S. B. M. is painted 20 feet upstream. Trees blazed with three notches: Stumpy oak, 18 inches, S. 85° E. 60 feet; sycamore, 6 inches, N. 42° E. 20 feet.

*Bench mark 73.*—Elevation, 651.5. Bolt driven to one-half inch of head, 5 feet above low water; cross mark cut in stone; U. S. B. M. and arrows in red paint; right bank, on bluff about 1 mile above Dallas Island. The bluff is 1,500 feet long and 30 or 40 feet high. Bench mark is 600 feet below beginning and 300 feet above vertical part, on a long, sloping rock face. Bench mark is on a rounded projection 4 by 4 feet. Ten feet downstream is a flat, sloping face 15 by 15 feet, very smooth and clean, on which is painted U. S. B. M. Trees blazed with three notches. Pine, 10 inches, S. 83° 30′ W. 51 feet; pine, 14 inches, N. 51° W. 66 feet.

*Bench mark 74.*—Elevation, 647.4. Bolt driven to one-half inch of head, 3 feet above low water; cross mark cut in rock; U. S. B. M. and arrows in red paint; painted on face of rock looking downstream; right bank, on low ledge projecting 75 feet out from bank, pointing diagonally downstream, about 3,500 feet below foot of Dallas Island, and opposite mouth of Ooltewah Creek. Bench mark is 5 feet from water at the point of rock most projecting at low water.

*Bench mark 75.*—Elevation, 647.6. Bolt driven to 1 inch of head, 4¼ feet above low water; cross mark cut on rock; U. S. B. M. and arrows in red paint; left bank. on flat projection of bluff at foot of Harrison Bar, 1 mile below Harrison Ferry. Bench mark lies 600 feet below upper and 150 feet above lower end of bluff on ledge 30 by 10 feet, projecting from bluff at its most precipitous part. Bench mark is 8 feet from water's edge and 10 feet from upstream end of ledge. Rock rises vertically behind bench mark for 15 feet, then there is a wide ledge and again behind a steep face. Off bench mark the water is deep, but 50 feet upstream and 50 feet downstream rocks lie along the bank.

*Bench mark 76.*—Elevation, 646. Bolt driven to 1 inch of head, 3 feet above low water; cross mark cut in rock; U. S. B. M. and arrows in red paint; right bank on bowlder lying at foot of rocky hill, about 1¼ miles below Harrison Bar. Bench mark is on bowlder 20 by 22 feet and 6 feet high, and is about 4 feet below highest point. It is the farthest upstream of a group of large bowlders. Trees blazed with three notches: Willow, 14 inches, N. 52° 30′ W. 41¼ feet; birch, 24 inches, N. 89° W. 46 feet; birch, 14 inches, S. 72° W. 38¼ feet.

*Bench mark 77.*—Elevation, 648.1. Stone 4 inches by 12 inches, 8¼ feet above low water; cross mark and U. S. cut in; buried to face; left bank, 3,500 feet above upper Chickamauga Island, 30 feet above branch from Smith Spring, 20 feet from river. Trees blazed with three notches: Birch, 12 inches, N. 11° E. 11¼ feet; leaning birch 10 inches, N. 74° W. (lowest notch) 7 feet; elm, 12 inches, S. 22° 30′ W. 10 feet; sycamore, 48 inches, S. 60° E. (lowest notch) 12 feet.

*Bench mark 78.*—Elevation top of pin, 613.8. Bolt driven in side of lower detached drawbridge pier to Cincinnati Southern Railway bridge, 6 feet above low water. About center of second stone from right edge facing downstream, third layer above low water and ninth below layer in which are placed two iron rings.

*Bench mark 79.*—Elevation, 612.4. Flat stone marked U. S. buried flush with ground, 6¼ feet above low water, 100 feet below mouth of S. Chickamauga Creek. Left bank 20 feet from water's edge. Trees blazed with three notches: Maple, largest of clump, 30 inches, N. 90° E. 36 feet; hackberry, S. 33° 30′ E. 22 feet; birch 24 inches, S. 59° 30′ W. 26 feet.

*Bench mark 80.*—Elevation of zero, 630.64. Vertical portion of river gauge above Chattanooga bridge.

*Bench mark 81.*—Elevation, 637.3. Bolt on downstream side of second pier from left bank of Chattanooga bridge 6 feet above low water.

*Bench mark 82.*—Elevation, 684. On water table of building now occupied by Bradt Printing Company, at southwest corner of Sixth and Market streets, Chattanooga.

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[*] Not printed.

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### 2. BELOW BEE TREE SHOALS (225 MILES).

Information pertaining to the section of the river below Bee Tree Shoals (Riverton, Ala.) is very limited. In 1864–'65 a reconnaissance of the Tennessee River from Paducah to Florence (225 miles) was made by a party of the United States Coast Survey, the data thus obtained to be for the use of the Mississippi squadron under the command of Acting Rear Admiral S. P. Lee, U. S. Navy. The "notes" pertaining to the map of the survey states that:

> The stages of water in the Tennessee may be divided into low, ordinary, and high water. A low stage of water prevails under usual circumstances for three months of the year; a medium or ordinary stage lasts, generally, five months, and a high stage four months.
>
> The average depth of the river at a low stage is, on all the bars, 3½ feet, excepting Duck River Shoals and Big Bend Shoals, on which 6 inches less is found at such a stage. This applies, however, only to the river below Chickasaw. The average depth at a medium stage may be considered 9 feet on the bars. At this stage only the Green Bottom Bar is bare.

Green Bottom Bar, Duck River Shoals, and Big Bend Shoals, above referred to, are distant 88 miles, 108 miles, and 199 miles respectively, from mouth of river. Chickasaw Settlement, 225 miles, is now known as Riverton, Ala. This section of the river has been heretofore covered by the surveys, estimates, and appropriations for the Tennessee

River below Chattanooga, and no special allotments have been made for the river below Bee Tree Shoals from the allotments for the river made from the general appropriations by acts of 1868 and 1869 and the appropriations from 1870 to 1892, inclusive, aggregating the sum of $4,183,000.

A survey was completed in December, 1867, from Chattanooga to mouth of river, and an estimate of $40,000 submitted for removal of obstructions and construction of wing dams below Florence, 255 miles. (Report of Chief of Engineers, 1870, p. 389.)

Maj. Walter McFarland, Corps of Engineers, speaking of the Lower Tennessee, in his report on lines of water communication between the Mississippi River and the Atlantic (Report of Chief of Engineers, 1872, p. 513), states that—

> Descending the river we find that improvements of some kind or other—removing rock or gravel or constructing wing dams, in order to straighten or widen the channels or to give them sufficient depth—will be required at the following points, viz: Bear Creek Shoals, Indian Creek, Big Bend Shoals, Diamond Island, Wolf Island, Chalk Bluff, Beech Creek Shoals, Buffalo Shoals, Armstrong's Towhead, bridge at Johnsonville, Duck River Shoals and Suck, Turkey Island Shoals, White Oak Island, Harrican Island, Leatherwood Shoals, Sandy Island, Panther Creek Island, McCulloughs Bar, Blood River Island, Pentecost Towhead, Widow Reynolds Bar, Grubbs Towhead, Little Chain, and Grand Chain.

In 1878 and 1879 some work was done at Duck River Shoals, 117 miles below Bee Tree Shoals. This shoal is a gravel bar, and is subject to considerable change from the action of the current. In 1881 and again in 1890 a small force with a snag boat was employed a short time in each year removing from the channel a large number of snags and overhanging trees. In 1882 the following localities below Rockport, about 4 miles below mouth of Duck River, were reported as requiring improvement: Duck River Suck, Johnsonville, Reynoldsburg Island, Turkey Island, Sandy Island, Little Chain, and Big Chain. It is stated in the Annual Report of the Chief of Engineers, 1892, p. 1915, that—

> During the last fifteen years the improvement of the river below Bee Tree Shoals, and in fact below Florence, has not received the attention its commerce and navigation appears to be justly entitled to, owing to the almost imperative necessity of concentrating all efforts and expending all moneys appropriated for the river "below Chattanooga" upon the removal of the main obstruction to navigation, until recently the impassable barrier of the Muscle Shoals. However, during that fifteen years a small amount of work was done, as above stated, below Riverton, foot of Bee Tree Shoals, Alabama.

| | |
|---|---|
| In 1878 and 1879, in the channel at Duck River Shoals, amounting to | $7,304.95 |
| In 1881 and 1882, snagging, etc | 3,373.04 |
| In 1890, snagging, etc | 1,365.33 |
| Total below Bee Tree Shoals from 1875 to 1891 | 12,043.32 |

> For the reasons stated and from information received from various sources it is believed that the condition of the Lower Tennessee demands an accurate survey. The Muscle Shoals Canal, opened to navigation November 10, 1890, and the work now in progress at Colbert Shoals and Bee Tree Shoals, make it very important that the Lower Tennessee River, from the foot of Bee Tree Shoals to the mouth of the river, be put in such condition as to permit the safe passage at all seasons of any boats capable of navigating the Muscle Shoals Canal and the proposed Bee Tree and Colbert Shoals Canal now in course of construction. In order to accomplish this it will be necessary to have an instrumental survey made of this section as soon as possible, to obtain detailed maps of the obstructions, with a complete profile of the river, so that estimates can be made and project for the radical improvement of the river below Riverton, Ala., be submitted, based upon the necessary and definite data that can only be thus obtained.
>
> If the Tennessee below Bee Tree Shoals is to be radically improved, it is very necessary, as above suggested, that an instrumental survey be made as soon as practicable, for the reason that the surveys, so called, heretofore have been rapid recon-

noissances or examinations, and do not furnish the data necessary whereon to base an economic, advantageous, and energetic prosecution of any work of improvement that may be projected.

The river and harbor act of September 19, 1890, appropriated for—

> Improving Tennessee River below Chattanooga, Tenn., including Colbert Shoals and Bee Tree Shoals: Continuing improvement, $475,000, out of which $25,000 may be used at Livingston Point, at the mouth of said river, in accordance with the recommendation of the engineer in charge of that portion of the river.

The river and harbor act of July 13, 1892, appropriated for—

> Improving Tennessee River below Chattanooga, Tenn.: Continuing improvement, $500,000, of which $25,000 may be used in continuing the work at Livingston Point, Kentucky.

Total amount allotted for Livingston Point, Kentucky, $50,000.

The recommendation referred to in the act first above cited is contained in House Ex. Doc. No. 172, Fifty-first Congress, first session, containing the report of Lieut. Col. William E. Merrill, Corps of Engineers, concerning improvement of Livingston Point, Kentucky, which is described in the annual report of the Chief of Engineers, 1892, p. 1916, as follows:

> *Livingston Point.*—This is a narrow strip or tongue of land lying between the waters of the Ohio and Tennessee rivers, just above the mouth of the latter stream. This point and two small islands below it form the harbor of Paducah, and by their position prevent the ice-bearing current of the Ohio from entering the harbor, which is supplied with the warmer waters of the Tennessee flowing from a southern latitude and rarely if ever troubled by ice.
>
> The currents of the two streams are parallel for about a mile on either side of Livingston Point, and the Ohio River is rapidly encroaching upon this narrow barrier. The Tennessee River does but little damage. Near the extreme end of the point the Ohio has washed through at high water.

A survey of Livingston Point was made in December, 1890, and based upon the data thus obtained a project for its preservation, with an estimate of $180,000, was submitted January 12, 1891, to the Chief of Engineers, which was approved by the Secretary of War on the 16th of January.

As stated in Report of Chief of Engineers, 1891, p. 2256—

> The plan of improvement adopted for preserving this point from destruction consists in covering the wearing slopes with a revetment of stone and brush carried well down the bank below the water surface, supplemented by a pile-and-stone dike along the crest of the weakest portion of the line, where the current of the Ohio has already cut through at high stages of the river, the object of both works being to hold in its present position the land now existing, and to cause, if possible, a further deposit of sediment on the Tennessee side of the dike, which from the present indications is likely to occur.
>
> The revetment of stone and brush is specially needed on the Ohio side and will be but sparingly required on the Tennessee side. It will be carried well below low water, where it will consist of brush weighted down with stone in alternate layers. From low water to foot of dike broken stone will be carefully placed.

The amount expended, including outstanding indebtedness, to the close of the fiscal year ending June 30, 1892, was $22,964.30, which has secured the completion of the dike on the Ohio side across the "washout" near the extremity of the point for a distance of 660 feet, and the protection of the bank for a length of 2,330 feet, extending 632 feet above the dike, and 1,038 feet below it, the average width being 47 feet; all the work being done on the bank facing the Ohio River so as to protect at once the low part of the exposed strip or "point," which was in great danger of washing away.

On October 8, 1892 advertisements were issued, soliciting proposals for continuing the construction of the shore protection at Livingston Point, Kentucky. Bids were opened on October 26, 1892. Contract was entered into November 9, 1892, with Mr. Frederick Hartweg, of Cincinnati, Ohio, for furnishing the stone and brush in place, at $1.23 per cubic yard and 94 cents per cord, respectively. The work to be completed on or before November 9, 1893. The total consideration of the contract being $10,780, estimated. Work was carried on under this contract in December and April and 2,000.47 cubic yards of stone were deposited in place, but high water and inclement weather prevented operations during the rest of the fiscal year.

Amount expended during the fiscal year was $1,459.29.

Having reference to the bridges spanning the Lower Tennessee, of which formal complaint has been made and action taken by the Secretary of War—

(1) The removal of the rest piers of the bridge of the Newport News and Mississippi Valley Company at Gilbertsville, Ky., is completed. By direction of the Secretary of War the rest piers were to be wholly removed to a depth of not less than 6 feet below extreme low-water mark. The said company reports in letter of recent date that the piers "have been removed to a depth of 6 feet or more below extreme low water," but verification by the engineer officer in charge was not practicable before submission of this report.

(2) The bridge of the Nashville, Chattanooga and St. Louis Railway Company at Johnsonville, Tenn., having been reported upon as an unreasonable obstruction owing to the faulty construction of the draw and the large deposits of stone placed around the piers to strengthen them, an alteration of the obstructing bridge was taken under consideration by the War Department. The plan for the modification of the existing structure having been submitted to the Secretary of War was by him approved, the work to be entirely completed by November 15, 1894.

No survey has been made of the Tennessee River below Bee Tree Shoals nor project or estimate submitted for its improvement.

| | |
|---|---|
| Estimate of cost of preserving Livingston Point, Kentucky............. | $180,000.00 |
| Amount appropriated by allotment.................................... | 50,000.00 |
| Amount expended.......................................................... | 24,423.59 |

NOTE.—The money statement is included in that for improvement of the Tennessee River below Chattanooga—Appendix E E 1, p. 2430.

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## REPORT OF MR. R. R. THACHER, SUPERINTENDENT.

CANEY CREEK SHOALS, *June 30, 1893.*

CAPTAIN: I have the honor to submit the following report of operations upon the Tennessee River for the fiscal year ending June 30, 1893:

That portion of the fleet lying at Chattanooga was towed to Soddy Shoals, a distance of 23 miles, on August 17, 1892, to begin active operations. In order to expedite matters it was deemed advisable first to construct an incline from the quarry to the river to convey the stone to the barges by the use of dumping cars, and thereby avoid the necessarily slow manner of handling the stone by means of derricks.

Work on the incline progressed rapidly, cribs were built out from bank to a required depth of water, and some excavation was done between the quarry and the river bank, in order to attain a practical grade.

By September 17 the water had fallen low enough to permit of work in the channel. The force began drilling, by hand, on the lower reefs, which were submerged on an average to the depth of 2 feet. It was necessary to build temporary tripod dams above the reefs to check the current; the tripod dams were removed as the work progressed, and portions of the dams had to be removed several times to allow the passage of steamboats, etc., and then replaced, which retarded the work and added to the cost of the excavation.

The steam derrick boat arrived from Hiwassee River September 12 and was put to work with the No. 5 Rand steam drill on the upper reefs, just below Soddy Creek.

In order to facilitate channel excavation a hole was cut in Dam No. 2, by this means a quantity of water was turned from the channel which considerably lessened the depth of water on the reefs, then with the aid of tripod dams the work progressed very satisfactorily. Six hundred and thirty-five cubic yards of solid rock were blasted and removed from the upper and lower reefs. A large quantity was also blasted and washed downstream by the force of the current and lodged in the uneven places and crevices. In consequence of the excavation, a clear channel 100 feet wide and of an average depth of 3 feet was obtained.

When drilling in the channel was abandoned, the steam derrick boat was dropped down to the quarry and a smaller steam drill was set to work in quarry, the derrick boat furnishing the steam. The use of the steam drill reduced the expense of quarrying one-half.

The lower end of Dam No. 4 was lengthened out 190 feet. The upper end was extended 555 feet, with a view to turning an angle of 33 degrees to the right, then submerge to the bank.

A small dam, No. 5, was built from the north bank 186 feet on the main lower reef to hold up and replace the water that would be "pulled" from the channel by removing the reefs. It was intended to build two more of these dams just below to straighten the current.

Dam No. 3 was reinforced with stone and the upper part thoroughly calked with small stone, clay, and gravel, on the channel side, over a distance of 1,200 feet from the island. This dam was originally a "State" crib dam built with logs; the Government rebuilt it with stone; it leaked so badly that it held up no water to speak of. The rock taken from the upper reefs was placed along this dam in small spur dams 15 to 20 feet apart, 6 to 8 feet in length; then the calking was applied. This dam being quite low in places was raised at the island; 1,200 feet below other necessary repairs were done. The "Ebenezer" that was on the lower end of this dam was built up so boats could see the end of the dam at night; before it was built they would strike the submerged end.

A small steamboat was hired to tow stone to the dams which, with the rapid loading by the incline, reduced the cost of building dams to about $1 per cubic yard.

Trees were cut from the channel and snags and logs removed. Owing to high water, work was suspended for the season and the entire fleet was moved to Chattanooga, December 19, for the winter. The last work at Soddy Shoals is giving satistion.

Operations were resumed on April 18, 1893, by towing the fleet from Chattanooga to Caney Creek Shoals, a distance of 90 miles. Camp privileges and quarry rights were obtained at Caney Creek Shoals, with necessary right of way for the incline and to and from the spring, road, and quarry; also to dig a well.

A quarry was opened May 16, which is in active operation, using a steam drill—steam furnished from a small boiler purchased this spring. A quarry has been opened on the south bank at the head of the shoals. There have been many repairs made to fleet and tools; the capstan on the steam derrick boat has been torn out and one erected on upper deck. The quarter boats have been furnished with hogchains, and the cabins repaired. Two No. 4 steam drills have been added to the plant.

The Three Rivers Packet Company of Knoxville, Tenn., have put one of their boats on the Tennessee, running from Knoxville to Chattanooga weekly, and is doing a good business.

Very respectfully, your obedient servant,

R. R. THACHER,
*Superintendent.*

Capt. JOHN BIDDLE,
*Corps of Engineers.*

## COMMERCIAL STATISTICS.

*List of steamboats (stern-wheel) plying on Tennessee River above Chattanooga, Tenn.*

| Name. | Length. | Breadth. | Depth. | Tonnage. | Name. | Length. | Breadth. | Depth. | Tonnage. |
|---|---|---|---|---|---|---|---|---|---|
| | *Feet.* | *Feet.* | *Feet.* | *Net.* | | *Feet.* | *Feet.* | *Feet.* | *Net.* |
| C. M. Fouche | 93 | 14 | 2 | 61.12 | Wyeth City | 120 | 22.5 | 4 | 138.96 |
| Dayton | 142 | 24.7 | 3.8 | 195.63 | Walter R. Love | 112 | 18 | 3.5 | 80.14 |
| J. R. Hughes | 98 | 17 | 3 | 95.15 | Clinton B. Fisk | 100 | 18 | 3.4 | 79.89 |
| J. C. Warner | 142 | 31.6 | 4.6 | 201.05 | Key City | 80 | 15 | 3.2 | 59.45 |
| J. W. Bussell | 76 | 9 | 2.8 | 24.60 | Maud | 79 | 16.5 | 3.2 | 23.30 |
| Lucille Borden | 86 | 14 | 2.5 | 55.32 | Hattie McDaniel | 90.5 | 18 | 2.5 | 90.63 |
| Oliver King | 60 | 8 | 2 | 29.30 | J. P. Kendrick | 112 | 20 | 3.7 | 128.71 |
| Pin Hook | 94 | 18 | 3 | 90.60 | Ruth Dodd | 37.5 | 7 | 3.7 | 11.12 |
| R. C. Gunter | 153 | 28 | 4 | 337.30 | Vollette | 45 | 8.5 | 3.1 | 15.05 |
| Rockwood | 130 | 25.6 | 4 | 150.52 | Verona | 43.2 | 11 | 2 | 6.13 |
| R. T. Coles | 118 | 24.6 | 4.2 | 134.91 | Harriman | 30 | 7.5 | 4 | 5.93 |
| Tallassee | 60 | 12 | 2 | 22.16 | John A. Hart | 41 | 7 | 2.1 | 5.63 |

*List of steamboats (stern-wheel) plying upon Tennessee River below Chattanooga, Tenn.*

| Name. | Length. | Breadth. | Depth. | Tonnage. | Name. | Length. | Breadth. | Depth. | Tonnage. |
|---|---|---|---|---|---|---|---|---|---|
| | *Feet.* | *Feet.* | *Feet.* | *Net.* | | *Feet.* | *Feet.* | *Feet.* | *Net.* |
| Allen J. Duncan | 165 | ....... | 5 | 319.46 | D. O. Brooks | 75.5 | 17 | 3.5 | 54.[illegible] |
| Clyde | 181 | 32.5 | 5.6 | 382.96 | Gus Genin | 120 | 20 | 4 | [illegible] |
| C. Smith | 132 | 29 | 3.5 | 226.39 | Mary N | 60 | 14 | 3 | [illegible] |
| W. F. Nisbet | 200 | 35 | 5.5 | 576.86 | Ida | 80.5 | 14.8 | 6.6 | 37.[illegible] |
| City of Paducah | 190 | 32 | 6 | 365.58 | Helene | 194 | 33 | 4.5 | 352.[illegible] |
| City of Savannah | 186 | 31 | 5 | 335.55 | City of Florence | 160 | 32 | 5.3 | 354.[illegible] |
| City of Sheffield | 180 | 35 | 5 | 329.74 | Charley McDonald | 150 | 30 | 4.5 | [illegible] |
| Wyandot | 91 | 18 | 3 | 65.94 | Excel | 122 | 21.5 | 3.5 | 118.[illegible] |
| Albert S. Willis | 152 | 26 | 4 | 132.99 | Jennie Campbell | 147 | 28 | 4.5 | 225.[illegible] |
| Andy | 75 | 14 | 5 | 43.40 | Louis Houck | 210 | 37 | 6.5 | 911.[illegible] |
| Corinne | 46.5 | 8.4 | 4.6 | 13.39 | George Lyle | 173 | 33 | 6 | [illegible].74 |
| Corinne No. 2 | ....... | ....... | ....... | 24.32 | Josie | 143 | 28 | 5 | 237.[illegible] |
| Iron Side | 154 | 30 | 6 | 280.80 | Eagle | 155 | 24 | 5 | 231.[illegible] |
| Iron Age | 176 | 38 | 6 | 385.91 | Hiawatha | 140 | 30 | 5.5 | 265 |
| Jennie Gilchrist | ....... | ....... | ....... | 74.48 | Iron Duke | ....... | ....... | ....... | 421 |
| Annie Barnes | 53 | 10.7 | 3 | 14 | Chattanooga | ....... | ....... | ....... | 261.[illegible] |
| Frank Burnett | 50.5 | 9.2 | 2.8 | 7.61 | I. N. Hook | ....... | ....... | ....... | 53.[illegible] |
| Jennie Pearl | 53 | 10.4 | 4.5 | 9.13 | Walter R. Love | 112 | 18 | 3.5 | [illegible].14 |
| Pearl of Paducah | 61.1 | 15.5 | 5.7 | 13.23 | Tom Towle | ....... | ....... | ....... | [illegible] |

*Commerce of Tennessee River above Chattanooga, Tenn., from July 1, 1892, to June 30, 1893.*

| Articles. | Tons. | Articles. | Tons. |
|---|---|---|---|
| Coal | 9,900 | Lumber | 162 |
| Iron ore | 13,365 | Shucks | [illegible] |
| Grain | 6,939 | Eggs | [illegible] |
| Sand | 5,150 | Chickens | 13 |
| Tan bark | 412 | Guano | 12 |
| Hay | 739 | Cotton seed | 6 |
| Flour | 271 | Butter | 4 |
| Pease | 260 | Beans | 2 |
| Cattle | 226 | General merchandise | 2,[illegible] |
| Salt | 162 | Logs | 50,000 |
| Straw | 107 | | |

NOTE.—The logs reported as reaching Chattanooga were run out of the upper tributaries of the Tennessee River in about the following proportions, viz:

| | Tons. |
|---|---|
| Powells River | 10,000 |
| Emory River | 4,000 |
| Little Tennessee River | 5,000 |
| Clinch River | 25,000 |
| Hiwassee River | 6,000 |

The Loomis & Hart Manufacturing Company, of Chattanooga, who kindly furnish the above information, state that the reason why more logs come to Chattanooga from the Hiwassee River than from the Little Tennessee River is because a large number are stopped at Loudon, Tenn.

During the present fiscal year regular water communication has been established between Knoxville and Chattanooga by the running of a line of light-draft steamboats, which is, it is reported, meeting with success.

*Commerce of Tennessee River below Chattanooga, Tenn., Alabama and Kentucky.—Below Bee Tree Shoals, Riverton, Ala.—From July 1, 1892, to June 30, 1893.*

| Articles. | Tons. | Articles. | Tons. |
|---|---|---|---|
| Railroad ties | 36,580 | Cattle | 1,276 |
| Lumber | 32,889 | Cotton seed | 1,118 |
| Grain | 10,782 | Sand | 701 |
| Shingles | 10,035 | Staves | 700 |
| Flour | 7,450 | Hogs | 665 |
| Salt | 6,907 | Hay | 350 |
| Iron | 3,729 | Horses and mules | 310 |
| Cotton | 2,335 | Bricks | 283 |
| Tobacco | 2,200 | Peanuts | 200 |
| Coal | 2,000 | General merchandise | 33,600 |
| Wood | 2,000 | | |

Number of passengers, 18,354.

## D D 3.

## IMPROVEMENT OF HIWASSEE RIVER, TENNESSEE.

The Hiawassee, or more correctly Hiwassee River, rises in the Blue Ridge, in western North Carolina and northern Georgia, and flowing in a west-northwesterly direction, enters the Tennessee River about 35 miles above Chattanooga and 148 miles below Knoxville. After breaking through the Smoky Mountain range and receiving the waters of the Ocoee, near Columbus, the Hiwassee becomes a stream of good capacity for navigation.

As early as 1830 the State of Tennessee made some minor improvements, but the work was only of temporary advantage. The act of Congress of June 23, 1874, authorized an examination of this river. The examination was made in September, 1874, under the direction of Maj. Walter McFarland, Corps of Engineers. (See Report of Chief of Engineers, 1875, pages 809 to 813.) The principal obstructions were found to be rock reefs, gravel bars, snags, and overhanging trees, and are of the same general character as those on the Upper Tennessee, and the regimen of the river is equally permanent.

The project for the improvement was based on this examination, and consisted in narrowing the waterway by wing dams at the shoal places, and excavating rock reefs and gravel bars so as to secure a navigable channel 40 feet wide and 2 feet deep at ordinary low water to Savannah Ford, about 43 miles from mouth of the river.

The original estimate submitted in 1875 was increased from 1878 to 1884, inclusive, to $36,500, which amount has been covered by the ten appropriations made for this improvement, viz:

| Act of— | | Act of— | |
|---|---|---|---|
| August 14, 1876 | $10,000 | July 5, 1884 | $2,500 |
| June 13, 1878 | 10,000 | August 5, 1886 | 2,500 |
| March 3, 1879 | 3,000 | August 11, 1888 | 1,000 |
| June 14, 1880 | 3,000 | September 19, 1890 | 1,500 |
| March 3, 1881 | 1,500 | | |
| August 2, 1882 | 1,500 | Total | 36,500 |

No appropriation was made for this river by act of July 13, 1892.

The amount expended to June 30, 1892, including outstanding indebtedness, was $33,338.78.

The last Annual Report states that—

> The work has resulted in a partial improvement of the lower river, securing an increased depth of channel and the removal of surface obstructions and overhanging trees.
>
> The work was done at different times at the following obstructions: Matthew Shoals, McElrath Shoals, Sivils Shoals, Magills Islands, Blackbird Shoals, Graves Ferry and Shoals, Canefield Reef, Lasters Creek Shoals, Brindley Shoals, Denton Island Shoals, Boyd Shoals, Horseford Shoals, and Gamble Shoals. The Hiawassee is now navigable for steamboats from its mouth to Charleston, 21 miles, during the boating season on the Upper Tennessee River. Above Charleston to Savannah Ford flatboats are used for transportation.

The work was first begun in 1877 at Matthew Shoals, and at intervals since, as each appropriation became available, efforts have been made to improve the channel at this the principal obstruction to navigation.

From the commencement of the present fiscal year to September 10, 1892, a small working force was employed mainly at Matthew Shoals. In order to distribute the fall at this shoal a part of the main dam extending from the right bank, opposite the lower island, was removed, and a new spur dam, 167 feet long, built on a reef extending from the north bank, was constructed to back up the water. The effect has been very satisfactory to the extent of securing a reduction of the current's velocity opposite the lower island, but owing to high water and the exhaustion of the appropriation it was not practicable to complete the much-needed work. The other dams were straightened, raised, or strengthened where necessary; the banks also were protected by felling trees and placing brush in position, anchoring the same with stone: this resulted as desired in protecting the bank and deflecting the current to the opposite side of the river. A ringbolt was securely placed in position on end of lower dam to assist heavily laden ascending boats. The channel below Matthew Shoals was also cleared of snags, and overhanging trees, etc.

The work done during the fiscal year is summarized as follows:

| | | |
|---|---|---|
| Quarry stripped | cubic yards | 186 |
| Stone quarried | do | 176 |
| Stone placed in dams | do | 481 |
| Calking dams | do | 261 |
| Old dam removed | do | 137 |
| Ringbolt anchored | number | 1 |
| Snags removed | do | 10 |
| Overhanging trees cut down | do | 150 |
| Trees deadened and topped | do | 323 |

The amount expended during the fiscal year, including outstanding indebtedness, was $1,442.16.

Boats belonging to the Tennessee River Transportation Company ply upon this stream, running regularly once a week during the season of navigation. Small boats of about 100 tons capacity can navigate the Hiwassee River about eight months in the year.

The original estimate of cost of improving the Hiwassee River has been appropriated and that amount expended. If it be determined to do further work upon this stream, it would be advisable that an instrumental survey be made to obtain accurate data whereon to base a project and estimate for the radical improvement from its mouth to Savannah Ford. This stream, in common with other mountain streams, requires that the channel be kept clear of snags, logs, etc., brought down by the annual floods, and it is advisable that provision be made for such work, so that the advantages resulting from previous expenditures be maintained.

| | |
|---|---|
| Estimate of cost of improving Hiwassee River, Tennessee | $36,500.00 |
| Amount appropriated | 36,500.00 |
| Amount expended, including outstanding indebtedness | 36,449.89 |

### *Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $1,492.27 |
| June 30, 1893, amount expended during fiscal year | 1,419.12 |
| July 1, 1893, balance unexpended | 73.15 |
| July 1, 1893, outstanding liabilities | 23.04 |
| July 1, 1893, balance available | 50.11 |

COMMERCIAL STATISTICS, HIWASSEE RIVER, TENNESSEE, FROM JULY 1, 1892, TO JUNE 30, 1893.

| Articles. | Tons. | Articles. | Tons. |
|---|---|---|---|
| Grain | 1,467 | Eggs | 41 |
| Coal | 750 | Live stock | 32 |
| Sand | 338 | Cotton seed | 24 |
| Tanbark | 820 | Shucks | 21 |
| Pease | 178 | Straw | 17 |
| Guano | 165 | Hay | 11 |
| Cattle | 133 | Chickens | 4 |
| Flour | 80 | Butter | 1 |
| Salt | 77 | General merchandise | 418 |
| Lumber | 6,052 | | |

Number of passengers, 198.

NOTE.—A small steamboat, the *Plucky City*, of light draft and having the capacity of about 40 net tons, is now constructing at Chattanooga for use upon the Hiwassee River as a general trading boat.

## D D 4.

### IMPROVEMENT OF FRENCH BROAD RIVER AND LITTLE PIGEON RIVER, TENNESSEE.

The French Broad River (the Tahkeeostee, or Racing Water, of the Cherokees) is one of the largest tributaries of the Tennessee. This stream has its source in North Carolina, on the western slope of the Blue Ridge, enters the State of Tennessee at Paint Rock, and after a course of 121 miles unites with the Holston River 4½ miles above Knoxville, thus forming the Tennessee River.

An appropriation was made by the State of Tennessee about fifty-four years ago for the purpose of improving the rivers of the section then known as the "East Tennessee District," and the improvement of Seven Island Shoals, of the French Broad River, about 30 miles below Dandridge, was begun under direction of commissioners appointed by that State. The State of Tennessee also built some dams above Dandridge, but these, with the exception of a few repaired by the United States in 1881, have been removed during the progress of the work under the present project.

An examination was made of the French Broad in Tennessee, under authority of act of Congress, July 11, 1870, and the report upon it is to be found in the Report of the Chief of Engineers for 1871, pages 491 to 494. A reëxamination in Tennessee was ordered by Congress, in act of March 3, 1875, "from its junction with the Holston, at Knoxville, to Leadvale, Tenn." The estimate made in 1871 was resubmitted with the report of 1876.

Below Leadvale—mouth of the Nolichucky River—a distance of 90 miles, the river is impeded by the surface obstructions usually found in mountain streams. This stretch of river is exceptionally beautiful, broad, and adapted to navigation, especially below Dandridge about 50 miles. The fall being only about 1 foot per mile, the channel can be easily improved. From the junction of the Nolichucky River to the Tennessee State line, 31 miles, the French Broad is not susceptible of improvement except by slack-water navigation, the fall being 7 feet per mile.

The present project of improving the channel from mouth of river to Leadvale, about 90 miles, consists in removing surface obstructions, cutting down overhanging trees, and building wing dams where necessary, so as to permit the passage of boats drawing 2½ feet during the ordinary low-water season. Under this plan operations have been carried on at the most serious obstructions.

The following appropriations have been made by Congress for improving French Broad River, in Tennessee, viz:

| Act of— | | Act of— | |
|---|---|---|---|
| June 14, 1880 | $10.000 | August 11, 1888 | $10,000 |
| March 3, 1881 | 3,500 | September 19, 1890 | 10,000 |
| August 2, 1882 | 5,000 | July 13, 1892 | 15,000 |
| July 5, 1884 | 3,500 | | |
| August 5, 1886 | 6,000 | Total | 63,000 |

The total amount expended to the close of the fiscal year ending June 30, 1892, including outstanding indebtedness, was $47,984.24.

This expenditure has resulted in the improvement of ten of the principal obstructions below Dandridge by deepening and clearing the channel, removing fish traps, constructing and modifying wing dams, and revetting the banks where necessary. A list of these ten obstructions, with their distances below Dandridge and the work done at each to June 30, 1890, is given in the Annual Report of the Chief of Engineers, 1891, pp. 2262, 2263.

The improvements made at Seven Island Shoals during 1889 and 1890 are therein reported as the most important effected on the French Broad River in several years, and have resulted in making this obstruction navigable for steamers at stages of the river when upstream navigation was heretofore impracticable. The work at these shoals, although not completed, has done much good. Before any work was done here by the United States it usually took a steam-boat from one-half to one and a half days to go through, but now the passage can be made in forty-five minutes.

At Bryant Shoal the modification and enlargement of the old wing dam and the removal of bowlders from the channel has greatly improved navigation.

Great benefit has resulted from the improvement made at Jumping Moses Shoal, near mouth of the river, its dangerous condition having been greatly modified.

During the fiscal years 1891 and 1892 the improvements were continued at Bryant Shoals and Hanging Rock Shoals. The bar at the foot of Bryant Shoals was excavated and two dams constructed, running out from the north bank. The old dam extending from the foot of McCroskey Island was straightened and made parallel to the main current, then lengthened to hold water upon the shoal. Across the island chute, about 500 feet below the mouth of Pigeon River, a cut-off dam was built, submerging the bar complained of as shutting off all navigation during low water, through which the current will soon cut a good chute sufficient for the passage of boats.

At Hanging Rock Shoals the channel was changed from the north to the south side of Brabson Island. The new channel was cleared of snags, drift, etc., and some rock excavated. Eight dams were built, a retaining-dam at foot of island with two spurs jutting toward the new channel to divide the fall and guard against the formation of a bar near the foot of the main dam; the old dam on the south bank of the island was utilized and 185 feet added to it in the direction of the new channel; two dams were built out from the south shore of Brabson Island, and two dams across the head of the chute, closing the old channel, which was left open as long as possible, and no detention of boats resulted from the change.

The active operations during the year were small in extent and mostly of the nature of repairs. Work was carried on in October, November, and December, 1892; also in part of May and June, 1893, and was in progress at the close of the fiscal year. The first work done, lasting about three weeks, was at the Wesley Chute of the Seven Island Shoals, and consisted in riprapping the bank with stone; raising the upper spur dam, removing loose rock and snags from channel and cutting down overhanging trees. The remainder of the working season, about 8 weeks, was spent at Hanging Rock Shoals, the work consisting of strengthening the dams built in 1891, and cutting overhanging trees.

The *Stephen H. Long*, a steamer of light draft, about 14 inches, was built at Chattanooga, especially for use upon the upper Tennessee and its tributaries, and was paid for from the proceeds of the sale of steamer *McPherson* to the works on the Tennessee River between Chattanooga and the foot of Bee Tree Shoals. On May 11, the *Stephen H. Long* started from the Caney Creek Shoals of the Tennessee River with two barges in tow, on reaching Seven Island Shoals two additional barges were added to the fleet, which moved up to Hanging Rock Shoals, and work was resumed upon the upper dams.

The break in upper dam near the island, caused by the ice during the winter months, was closed and the dam strengthened from the north bank to the island; this work is not yet finished. The improvement at this obstruction has given entire satisfaction to the river interests, and as soon as completed, the chute at the Hanging Rock Shoals will be one of the safest and easiest to navigate on the river, and not, as heretofore, the most dangerous at a medium or low-water stage.

The work done during the fiscal year was as follows:

| | | |
|---|---|---|
| Quarry stripped | cubic yards.. | 541 |
| Stone quarried | do.... | 1,192 |
| Dams built (riprap) | do.... | 782 |
| Dams repaired (riprap) | do.... | 282 |
| Loose rock taken from channel | do.... | 32 |
| Sand and gravel taken from channel | do.... | 60 |
| Snags removed | number.. | 2 |
| Overhanging trees cut down | do.... | 130 |

The amount expended during the fiscal year, including outstanding indebtedness, was $4,712.87.

No work has yet been done having in view the removal of bar in Little Pigeon River, under the provision of the act of July 13, 1892, alloting $1,000 of the appropriation for improving the French Broad River for that purpose.

The improvement of the French Broad River, Tennessee, is of vital importance to the inhabitants along its banks, not only by reason of its increasing commerce, but because of its being constantly used as a highway for travel by the people themselves; a large number of passengers being carried by the small steamers that ply upon this stream. The commerce consists principally of marble, sand, logs, lumber, forage, grain, live stock, wood, and general merchandise. The completion of the existing project of improvement will materially aid in the development of the mines and will open a river highway for the transportation of the mineral wealth of the mountains and the products of the rich agricultural lands of the region drained by the river and its tributaries.

| | |
|---|---|
| Estimate of cost of improving French Broad River, Tennesee, from mouth to Leadvale | $150,000.00 |
| Amount appropriated | 62,000.00 |
| Amount allotted for little Pigon River, act of July 13, 1892 | 1,000.00 |
| Amount received: Sale of steamer *McPherson* | 900.00 |
| Amount expended, including outstanding indebtedness | 52,523.48 |

## *Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $189.39 |
| Received from sale of Str. *McPherson* | 900.00 |
| Amount appropriated by act approved July 13, 1892 | 15,000.00 |
| | 16,089.39 |
| June 30, 1893, amount expended during fiscal year | 3,759.31 |
| July 1, 1893, balance unexpended | 12,330.08 |
| July 1, 1893, outstanding liabilities | 953.56 |
| July 1, 1893, balance available | 11,376.52 |
| Amount (estimated) required for completion of existing project | 88,000.00 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895 | 30,000.00 |

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

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### COMMERCIAL STATISTICS.

*List of steamboats (stern-wheel) plying on the French Broad River.*

| Name. | Length. | Breadth. | Depth. | Net tonnage. |
|---|---|---|---|---|
| | *Feet.* | *Feet.* | *Feet.* | |
| C. M. Fouche | 93 | 14 | 2 | 61.12 |
| Oliver King | 60 | 8 | 2 | 29.[illegible] |
| J. W. Bussell | 76 | 9 | 2.8 | 24.[illegible] |
| Lucille Borden | 86 | 14 | 2.5 | 55.[illegible] |
| Hattie McDaniel | 90.5 | 18 | 2.5 | 90.[illegible] |
| Onega | 106 | 18 | 2.6 | 77.[illegible] |

*French Broad River, Tennessee, from July 1, 1892, to June 30, 1893.*

| | | |
|---|---|---|
| General merchandise | tons | 12,500 |
| Passengers | number | 6,940 |

The commerce was between Knoxville and Dandridge and intermediate points. The Tennessee River Transportation Company, of Chattanooga, Tenn., it is reported, intends to run a boat from Chattanooga in the French Broad River trade.

## D D 5.

### IMPROVEMENT OF CLINCH RIVER, TENNESSEE.

The Clinch River rises in the Cumberland Mountains, in southwestern Virginia, and flows in a southwesterly direction, generally parallel to the Holston River, and empties into the Tennessee River at Kingston, Tenn., 104 miles above Chattanooga and 79 miles below Knoxville; the length of its course in Tennessee being about 230 miles.

Between 1830 and 1845 work was done by the State of Tennessee, but it resulted in little or no advantage to navigation. The country drained by this river, about 1,436 square miles, is mountainous and has very meager transportation facilities other than are afforded by the Clinch River during "rain tides;" its valley being isolated by mountainous ranges running parallel so as to make the river the main highway of this region.

Under authority of act of Congress approved March 3, 1875, examination of the river was made both in Virginia and Tennessee. Osborns Ford, Virginia, about 35 miles northeast of the Tennessee line, is regarded as the head of high-water navigation on the Clinch River. It has no low-water navigation. (See Report of Chief of Engineers, 1876, pp. 736 to 747.) An examination of the Clinch River from Nash Ford, Virginia, to Haynes or Walkers Ferry, Tennessee, a distance of about 161 miles, was made in 1880. (See Report of Chief of Engineers, 1881, pp. 1864 to 1867.) The original project, submitted in 1876, provided only "to improve the high-water navigation of this river, so that there shall be less difficulty and danger in bringing out cargoes, and so that rain tides of 3 or 4 feet may be made use of for boating purposes." This was estimated at $26,400. In 1881 the engineer officer in charge reports that he hoped to attain a permanent increase of depth of water in channel, by blasting rock, etc., "securing for about 145 miles of the lower river, at ordinary low water from its mouth to Clinton, about 2 feet, and from Clinton to Walkers Ferry (Haynes) about 1½ feet," adopting the low-water channel, which in 1876 had been simply suggested as a channel that might be found practicable after a careful survey, and thus modifying the then existing project, but without increasing the original estimate for high-water navigation by the cost of the channel projected. In 1885, the estimate was increased to $50,000, "because it had been found necessary to make the channel from two to three times the width thought sufficient when the original estimates were made," but the estimate was not increased by reason of the adoption of the proposed low-water navigation as part of the present project.

The examinations made of the Clinch River are not sufficient whereon to base an estimate of the cost of the projected low-water channel below Walkers Ferry, but if radical improvement is to be undertaken it is recommended that a detailed survey be made to obtain the data necessary to determine the cost, having in view an advantageous and economical prosecution of the work.

Above Walkers Ferry to the Tennessee State line, about 85 miles, the only projected improvement is to reduce the ledges and remove loose rock, etc., sufficiently to assist flatboat navigation and rafting during "rain tides."

The following appropriations have been made for this improvement:

| Act of— | | Act of— | |
|---|---|---|---|
| June 14, 1880 | $10,000 | August 11, 1888 | $5,000 |
| March 3, 1881 | 3,000 | September 19, 1890 | 4,000 |
| August 2, 1882 | 3,000 | July 13, 1892 | 4,000 |
| July 5, 1884 | 5,000 | | |
| August 5, 1886 | 5,000 | Total | 39,000 |

The total amount expended to the close of the fiscal year ending June 30, 1892, including outstanding indebtedness, was $34,962.29.

The general results attained by this expenditure are that the reefs have been reduced, many snags and overhanging trees removed, and several strong, heavy wing, and longitudinal dams built, thus securing a passable channel at stages of the water 2 or 3 feet lower than before the improvement was begun.

Above Haynes or Walkers Ferry special advantages were secured about ten years ago at Hunter Shoals, Sycamore Shoals, Hopson Shoals, and Straight Shoals.

Below Walkers Ferry (Haynes) important work has been done at Black Shoals and Bletcher Shoals; at Cloud Shoals seven dams have been built, and a heavy dam at Hibb Shoals, which, with the rock excavation in channel, have materially lessened the dangers to navigation. At Llewellyn Shoals, the improvements completed consist of reducing projecting rocky points, removing snags, sand, and gravel from the channel, completing wing dams, and constructing dam, 190 feet long, about 324 feet below Moores Ferry or Ford. Safe navigation at these shoals is now reported possible at a stage of water from 1 to 1½ feet lower than before the work done in 1892 was begun. At Young Island the fish-trap dam was taken from the chute south of the island, but more work is necessary to confine the water to one channel for the floating of logs to the mills below the island.

No work in channel was done during the fiscal year. Partial examinations were made in July below the mouth of Powell River, and in October, below the mouth of Emory River, having in view the ascertaining, in a general way, of what work is necessary to be done to improve the channel to the extent of securing a navigable depth of 2 feet at ordinary low water.

The amount expended during the fiscal year, including outstanding indebtedness, was $917.81.

Having reference to navigation and commerce upon the Lower Clinch River, the last Annual Report states that:

> The section of the river below Clinton, a distance of about 70 miles, is practicable for steamboat navigation during the higher stages of the river, and to increase the length of the season of navigation the present project contemplates the construction of wing dams and other channel work at the most troublesome obstructions. The principal navigation at present consists of logs and zinc ore. Immense tracts of uncut timber still remain in the country adjacent to this stream, and will for a long time to come require its channel as a means of transportation. The products of the zinc mines are still brought down in flatboats to the reducing-works at Clinton. These ore deposits are reported as being very extensive and practically dependent upon the river for transportation.

The Loomis & Hart Manufacturing Company, of Chattanooga, Tenn., reports that about 78 per cent of the logs reaching Chattanooga are run out of the Clinch and its tributaries, the Powell and Emory rivers; and that about 25,000,000 feet, B. M., or about 50,000 tons, of logs reached that city during the fiscal year; therefore about 39,000 tons were from the Clinch River.

| | |
|---|---|
| Estimate for improving Clinch River, Tennessee, as modified in 1885... | $50,000.00 |
| Amount appropriated | 39,000.00 |
| Amount expended, including outstanding indebtedness | 35,806.26 |

*Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $111.55 |
| Amount appropriated by act approved July 13, 1892 | 4,000.00 |
| | 4,111.55 |
| June 30, 1893, amount expended during fiscal year | 888.97 |
| July 1, 1893, balance unexpended | 3,222.58 |
| July 1, 1893, outstanding liabilities | 28.84 |
| July 1, 1893, balance available | 3,193.74 |
| Amount (estimated) required for completion of existing project | 11,000.00 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895 | 11,000.00 |

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

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COMMERCIAL STATISTICS.

*Clinch River, Tennessee, from July 1, 1892, to June 30, 1893.*

| | |
|---|---|
| Logs ....tons | 25,000 |

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## D D 6.

## IMPROVEMENT OF CUMBERLAND RIVER, TENNESSEE AND KENTUCKY.

The Cumberland River rises in eastern Kentucky, on the western slope of the Cumberland Mountains, flows in a tortuous course of about 688 miles through eastern Kentucky, middle Tennessee, and western Kentucky, and discharges into the Ohio River near Smithland, Ky. From Point Burnside, Ky.—the head of steamboat navigation—to Smithland, Ky., is 205 miles on an air line, while by the way of the Cumberland River the distance is 518 miles; 203 miles being in the State of Kentucky and 315 miles in the State of Tennessee.

From 1830 to 1840 the legislatures of Tennessee and Kentucky made several appropriations for the improvement of the navigation of the Cumberland River, but little benefit to the general condition of the river seems to have been accomplished. The Cumberland Navigation Company was incorporated by the State of Tennessee in 1846 for improving the "navigation of the Cumberland River below the town of Nashville by means of a system of locks and dams," but nothing tangible was done to carry out the proposed improvement.

Congress appropriated $155,000 for improving the river by acts of—

| | | | |
|---|---|---|---|
| July 17, 1832 | $30,000 | July 7, 1838 | $20,000 |
| June 28, 1834 | 30,000 | | |
| July 7, 1836 | 20,000 | Total | 155,000 |
| March 3, 1837 | 55,000 | | |

This amount was expended in carrying out the project authorized by act of Congress and based on the survey of Capt. Howard Stanbury.

From 1838 to 1871 no appropriations were made by Congress for improving the Cumberland River.

By act of July 11, 1870, Congress authorized an examination and survey of the Cumberland River. In Reports of the Chief of Engineers, 1871, pp. 468–485, and 1872, pp. 463–472, may be found the reports of Maj. Godfrey Weitzel, Corps of Engineers, U. S. Army, giving description of the Cumberland River from the Great Falls of the Cumberland to the mouth of the river at Smithland, Ky. This survey furnished the basis of the project under which the work below Nashville has been done, the original estimates having been increased in 1884 and 1888. From Nashville to Smith Shoals the work was carried on under the project of 1871 until 1887. A survey of the river from the head of Smith Shoals to Nashville was made in 1882 and 1883. (See Report of Chief of Engineers, 1884, pp. 1663–1675.) On this survey is based the present project of improvement by locks and dams of the Cumberland River above Nashville. A survey of Smith Shoals made in 1874 (see Report of the Chief of Engineers, 1875, pp. 795–800) is the basis of the project under which work was done at that obstruction from 1877–1883. A survey of the falls of the Cumberland River was made in 1878. (See Report of the Chief of Engineers, 1879, pp. 1279–1282.) An examination above the falls was made in 1880. (See Report of the Chief of Engineers, 1881, pp. 1854–1859.)

Under provisions of act of August 11, 1888, a detailed instrumental survey was made of the "Lower Cumberland River from Nashville to its mouth, to ascertain if necessary to establish locks and dams." (See Report of the Chief of Engineers, 1890, pp. 2151–2161.)

The sixteen appropriations made by Congress from 1871 to 1892 amount to $1,466,000, and are itemized under the heads of "below Nashville" and "above Nashville."

The obstructions are of a uniform character, consisting of rock ledges, gravel and sand bars, bowlders, snags, overhanging trees, and other surface obstructions.

The Cumberland River supplies in many cases, both above and below Nashville, the only means of transit between the towns and villages lying along its course.

### 1. BELOW NASHVILLE (191 MILES).

The Cumberland River is navigable below Nashville for all steamboats plying on it for six months in each year; for boats not drawing over 3 feet, from six to eight months; and for boats drawing 16 inches or less, for the whole year. In seasons of unusually low water the mouth of the river, at Smithland, Ky., is seriously obstructed by the formation of sand bars. Up to this time the work below Nashville has been carried on under the project of 1872, which, to quote from the original report, is—

> To excavate the bars and rock ledges to get an additional depth of water, to contract the water ways in places to get the requisite depth, to remove snags and bowlders from the main channel, and to restrain tributary streams in well-determined channels at their junction with the river.

The Board of Engineer Officers (see Chief of Engineer's Report, 1888, pp. 1626–1632) recommended the construction of a dike near Smithland, Ky., at an estimated cost of $129,600, so as to increase the depth of water on the shoals at the junction of the Cumberland River with the Ohio River. The river and harbor act approved September 10, 1890, provides that $30,000 of the appropriation for improving the Cumberland River below Nashville shall be expended in improving the mouth of the river, and the act of July 13, 1892, appropriated $40,000 for continuing the improvement, including the mouth of the river, and "that $10,000 of this sum, or so much thereof as may be necessary, shall be available for acquiring site and locating lock and dam near the mouth of Harpeth River, Tennessee, according to the survey and plan of Lieut. Col. Barlow, Corps of Engineers, U. S. Army, submitted in December, 1889." (See Report of Chief of Engineers, 1890, pp. 2152–2161.)

The following appropriations have been made for the section of the river below Nashville:

| Act of— | | Act of— | |
|---|---|---|---|
| March 3, 1871 | $30,000 | August 2, 1882 | $15,000 |
| June 10, 1872 | 20,000 | July 5, 1884 | 7,500 |
| March 3, 1873 | 25,000 | August 5, 1886 | 12,500 |
| March 3, 1875 | 25,000 | August 11, 1888 | 10,000 |
| June 18, 1878 | 45,000 | September 19, 1890 | 40,000 |
| March 3, 1879 | 40,000 | July 13, 1892 | 40,000 |
| June 14, 1880 | 20,000 | | |
| March 3, 1881 | 15,000 | Total | 345,000 |

The amount expended to June 30, 1892, including outstanding indebtedness, but not including the amount covered by existing contracts, was $287,694.70, which expenditure resulted in lengthening the season of navigation by giving an increased depth at low water, combined with the greater security in the passage of the worst obstructions, improvements more or less complete being effected in the general river at Harpeth Shoals, Palmyra Bar, Elk Creek Shoals, Dover Island, Gatlin Shoals, Race Track Shoals, Shelley Island, Ingram Shoals, Big Eddy Shoals, etc. Rebuilt and refitted United States snag boat *Weitzel* for snagging, etc., in Cumberland River, upon which work she was employed during part of the fiscal year 1892.

Good progress was made on the work of building dike and shore protection at mouth of the river under contract, 1,081 piles being driven and 10,045 cubic yards of stone and 1,637 cords of brush placed in dike and along the shore. By hired labor the old spur dams at mouth of the river were shortened so as to increase the width of channel; the shore of Cumberland Island in the vicinity of the dams was also protected by riprap. Buoys or floats were placed upon several dams in the channel at the principal shoals to mark the location of the dams during high water.

During the present fiscal year the work of dike construction and shore protection was continued at the mouth of the river under the only contract in force, being that entered into March 12, 1891, with Mr. Frederick Hartweg, of Cincinnati, Ohio. This contract has been extended four times, the time of completion being now, December 1, 1893. Operations were only practicable during July, August, December, 1892, January, and the last eight days of June, 1893. One thousand and forty-seven piles were driven, 6,577.75 cubic yards of stone and 351 cords of brush were placed in dike. The price for each class of work under this contract is as follows:

| | | |
|---|---|---|
| Piles in place | each | $2.00 |
| Timber in place, per 1,000 feet B M | | 22.50 |
| Stone placed in dike or as shore protection | per cubic yard | .94 |
| Brush placed in dike or as shore protection | per cord | .79 |
| Bolts in place | per pound | .04¼ |

On July 20 the United States steamer *Weitzel* left Nashville to clear the channel of the lower river of surface obstructions. Six cubic yards of loose rock, 226 snags, 65 drift logs, and 1,008 overhanging trees were removed between Nashville and Smithland. The dam at mouth of Harpeth River was repaired, 30 buoys were painted and placed on principal dams to mark their location at high water.

The old dams extending from Cumberland Island to head of dike were entirely removed, 586 cubic yards of loose rock, 150 cubic yards of sand and gravel, 71 cords of brush, and 35 snags being taken out.

From September 10 to the last of October about 3,150 linear feet of the bank above foot of Cumberland Island, opposite the Kentucky mainland, were protected by driving piles near the low-water line and the bank revetted with rock and brush, 1,092 piles were driven, 6,041 cubic yards of stone and 545 cords of brush were placed as revetment. The willows along the bank were cut sufficiently to be bent over to assist in forming a protection to the bank, the partly cut growth lying so thick that the surface was nearly covered. The work is completed and appears to be satisfactory. The bank is thought to be permanently protected.

In September the survey was begun having in view the selection of sites for lock and dam near mouth of Harpeth River, as provided by act of July 13, 1892, and was completed in April and the map of the survey early in June. The sites recommended for Lock and Dam A, located about 2½ miles below the mouth of Harpeth River, were submitted to the Chief of Engineers by my predecessor, Lieut. Col. Henry M. Robert, Corps of Engineers, and received the approval of the Secretary of War June 12. Action will be taken without delay to acquire title to these sites as soon as practicable.

The total amount expended during the fiscal year, including outstanding indebtedness but not including the amount pledged by existing contract, was $25,542.31, divided as follows:

| | |
|---|---|
| General improvement | $12,074.67 |
| At mouth of river | 8,698.92 |
| Lock and dam near mouth of Harpeth River | 4,768.72 |
| Total expended | 25,542.31 |

The commerce of the Lower Cumberland consists principally of grain, tobacco, logs, lumber, wood, general merchandise, and passengers.

The project for the radical improvement of the Cumberland River below Nashville, based on the survey of 1889 above referred to, provides for the construction of seven locks and fixed dams between Lock No. 1 of the upper series and Big Eddy Shoals, 144½ miles, each lock to be of the same dimensions as those above Nashville; that is, the lock chambers to be 280 feet long and 52 feet wide, the lifts of the proposed locks varying from 8½ to 11½ feet, aggregating a lift of nearly 70 feet. Certain channel work is provided for in the project between Big Eddy Shoals and mouth of the river. The improvement "at mouth of the river" between Smithland and the deep waters of the Ohio is also embraced in this project at a total estimated cost of $2,000,000, of which $150,000 were added in 1888 to the estimates previously submitted. Should this project for the canalization of the Lower Cumberland be adopted and an appropriation be made for the construction of a lock and dam at the approximate cost of $250,000, upon the sites to be acquired, as approved and as a part of the project, then the balance of $1,850,000 will be added to the estimates as the cost of improvement under this modified project, subject to the prior approval of the Chief of Engineers.

The balance of the estimate for work under the existing project, as modified, is $153,000, which can be profitably expended under the project, as follows:

| | |
|---|---|
| For dike and bank protection at mouth of river, balance of estimate (Report Chief of Engineers, 1888, p. 1631) | $99,600.00 |
| For protecting bank of Cumberland Island (Report Chief of Engineers, 1889, p. 1839) | 20,400.00 |
| For removing surface obstructions, channel excavation, construction of wing dams, etc | 33,000.00 |
| Total | 153,000.00 |

| | |
|---|---|
| The original estimate of cost of improving Cumberland River below Nashville, as modified in 1884 and 1888 | $498,000.00 |
| Amount appropriated | 345,000.00 |
| Amount expended, including outstanding indebtedness and amount covered by contract | 319,990.01 |

*Money statement.*

| | | |
|---|---|---|
| July 1, 1892, balance unexpended | | $17,462.16 |
| Amount appropriated by act approved July 13, 1892 | | 40,000.00 |
| | | 57,462.16 |
| June 30, 1893, amount expended during fiscal year | | 25,542.31 |
| July 1, 1893, balance unexpended | | 31,919.85 |
| July 1, 1893, outstanding liabilities | $214.86 | |
| July 1, 1893, amount covered by uncompleted contracts | 6,695.00 | |
| | | 6,909.86 |
| July 1, 1893, balance available | | 25,009.99 |

| | |
|---|---|
| Amount (estimated) required for completion of existing project | 153,000.00 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895 | 153,000.00 |

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

## 2. ABOVE NASHVILLE (497 MILES), FROM NASHVILLE TO CUMBERLAND FORD.

The Cumberland River is navigable from Nashville to Point Burnside, Ky., 327 miles, for steamboats drawing not more than 3 feet, from four to six months of each year, and for boats of greater draft from two to three months.

From Nashville to mouth of Caney Fork River (Carthage, 116 miles), the river is navigable for steamboats of 2½ feet draft, from six to eight months, and for those of greater draft, four or five months. Steamboats of light draft can ascend to Burksville, 236 miles above Nashville, for from five to seven months, and larger boats four or five months.

The obstructions in the river above Nashville are of the same general character throughout, consisting of ledges, gravel and sand bars, bowlders, snags, overhanging trees, and rapid currents; and of mill dams in the section of the river above the mouth of Jellico Creek. About 50 miles above Burnside, Ky., are the Great Falls of the Cumberland, a vast barrier to navigation, the difference of level between crest and foot of the main fall alone being about 54 feet. Smith Shoals, 10 miles above Burnside, Ky., having a fall of 55 feet in 8½ miles, form the most serious obstacle to navigation below the Great Falls.

The appropriations made by Congress for improving the Cumberland River above Nashville, under the original projects, were divided by years and geographical divisions as follows:

| Geographical division. | Acts of— | | | | | | | Total. |
|---|---|---|---|---|---|---|---|---|
| | Aug. 14, 1876. | June 18, 1878. | Mar. 3, 1879. | June 14, 1880. | Mar. 2, 1881. | Aug. 2, 1882. | July 5, 1884. | |
| 1. Nashville to Kentucky line | $15,000 | $20,000 | $18,000 | $15,000 | $15,000 | ........ | ........ | $83,000 |
| 2. Kentucky line to Smith Shoals | 10,000 | 8,000 | 6,000 | 10,000 | 15,000 | ........ | ........ | 49,000 |
| 3. Smith Shoals | 25,000 | 30,000 | 15,000 | 20,000 | 10,000 | $15,000 | ........ | 115,000 |
| 4. Smith Shoals to Falls of Cumberland | 2,000 | 2,000 | ........ | ........ | ........ | ........ | ........ | 4,000 |
| 5. Above the mouth of Jellico, Ky | ........ | ........ | ........ | ........ | 10,000 | 5,000 | ........ | 15,000 |
| 6. Nashville to Smith Shoals | ........ | ........ | ........ | ........ | ........ | 30,000 | ........ | 30,000 |
| 7. Nashville to head of Smith Shoals | ........ | ........ | ........ | ........ | ........ | ........ | $50,000 | 50,000 |
| Total | 52,000 | 60,000 | 39,000 | 45,000 | 50,000 | 50,000 | 50,000 | 346,000 |

These appropriations, aggregating the sum of $346,000, have been expended in the several sections as designated, excepting the sum of $5,000 originally appropriated by act of August 2, 1882, for the section "above the mouth of Jellico, Kentucky," but which was made available by act of September 19, 1890, for expenditure, and "to be applied to the removal of snags and sand bars in the said Cumberland River above Nashville, Tenn.," and which has been so expended. (Sec. 3, Cumberland River above mouth of the Jellico, Kentucky.)

The disbursements incident to the works above Nashville under the above-named appropriations were from March, 1877, to December, 1887, and the work done consisted of clearing the channel of snags and other surface obstructions, in deepening the channel over the worst shoals by excavation, and the construction of wing dams, and has resulted in obtaining an increased depth at several of the principal obstructions, and thus securing each year a longer and safer period of navigation.

The instrumental surveys of 1882 and 1883 (see Report of Chief of Engineers, 1884, p. 1663 *et seq.*) furnish the basis of the present project for the radical improvement of the Cumberland River.

## FROM NASHVILLE TO THE HEAD OF SMITH SHOALS.

This project provides for the construction of twenty-three locks and dams between Nashville and Burnside, Ky., and of seven locks and two dams at Smith Shoals, using the river itself as a canal, one dam at Mill Shoals and the other at or near Shadowen Shoals, at an estimated cost of $4,077,922, increased in 1891 to $7,500,000.

The act of July 5, 1884, appropriated $50,000 and provided that the "improvement shall be made according to the recommendation of Maj. W. R. King, engineer in charge, contained in the letter of Secretary of War, March 15, 1884, Senate Executive Document No. 129, first session, Forty-eighth Congress."

It is provided in said executive document that the dimensions of the seven locks at Smith Shoals are to be "55 feet by 140 feet in the chamber," and the twenty-three locks between Nashville and Burnside, Ky., "should be about 60 feet wide, and 250 feet between miter sills, though perhaps smaller dimensions would answer the purpose."

The act of August 5, 1886, specifically provided for this work of canalization "with a view to secure in the channel a depth of 4 feet, commencing with the lock at or near the lower island at Nashville." The board of engineer officers constituted to examine and report upon the plan and estimate for this lock (No. 1) recommended a lock of the following dimensions: 280 feet long, 52 feet wide, from 10 to 12 feet lift, with 4 feet of water on lower and 5 feet on upper miter sill. This recommendation was approved by the Chief of Engineers and the Secretary of War. (See Report Chief of Engineers, 1888, p. 1622 *et seq.*)

The plans first submitted provided for a lock (No. 1), fixed dam, and abutment of such dam, but upon further consideration by a board of engineers it was recommended conditionally and approved that a movable dam be constructed instead of a fixed dam. (See Report Chief of Engineers, 1890, p. 2143 *et seq.*) This board, in a subsequent report dated November 26, 1890 (6793–1890), for reasons therein given, withdrew its former suggestion and recommended the construction of a fixed dam as originally proposed.

The board of engineers constituted to examine and report upon the plan and general design of Lock 2 recommended in their report of November 25, 1890 (6727–1890), a lock of 280 feet available length, 52 feet interior width, conforming to the dimensions prescribed for Lock 1, but recommending a depth of 6½ feet of water on the upper miter sill, and thus to provide for a minimum navigation of 6 feet instead of 4 feet, because "this can be done without extra cost," and "is necessary for the economical transportation of coal."

The plan for Lock No. 2, as approved, shows a uniform depth of 6½ feet of water on the sills.

The style of dam being thus determined, new plans for Lock No. 1, providing for a depth of water of 4 feet on the lower and 6½ feet on the upper miter sill, and for a fixed dam and abutment, were submitted to the Chief of Engineers and by him referred to a board of engineer officers, who in their report of April 20, 1891, recommended the plans for approval, the report of the board being approved by the Secretary of War, April 25, 1891, the plan for Lock No. 1 submitted being "almost identical with the * * * plans for Lock No. 2." (See Report Chief of Engineers, 1891, p. 2280 *et seq.*) Lock No. 1 having a lift of 9 feet, and Lock No. 2 a lift of 11 feet.

Locks of larger dimensions having been adopted for the section from Nashville to Burnside, Ky., as a modification of the existing project, it became necessary to revise the estimates submitted in 1882 and 1883, and such revision was made in the Annual Report of the Chief of Engineers, 1891, p. 2270, as follows:

> Plans and estimates for Locks Nos. 1 and 2 have been prepared and contracts for portions of the work have been made, from which it is now estimated that each lock and dam will cost not less than $250,000. An estimate of the section from Nashville to Point Burnside, provided twenty-three locks be found necessary, amounts to $5,750,000, and to continue the improvement to the head of Smith Shoals with seven additional locks and dams of equal cost, would amount to $1,750,000 more, or a total of $7,500,000, an increase of the original estimate by $3,422,078, which modification is made and submitted in this report. By increasing the lift of the locks it may be found possible to decrease their number and thus complete the improvement at a reduced cost.

The appropriations made for work under the present project from Nashville to the head of Smith Shoals are as follows:

| Act of— | |
|---|---|
| August 5, 1886 | $75,000 |
| August 11, 1888 | 200,000 |
| September 19, [illegible]0 | 250,000 |
| July 13, 1890 | 250,000 |
| Total | 775,000 |

In 1892 the engineer officer then in charge, having under consideration the object of improvement, the provisions of the several acts of Congress relating thereto, and the needs of the work bearing upon its rate of progress and time of completion, together with the contingencies developed since its commencement, reported that—

The board of engineers of 1887 in its report on this improvement says: "The locks on the Cumberland River are assumed to be specially intended for the development of the coal traffic on the Upper Cumberland." While one member dissented from the recommendation of the board as to the size of the locks, thinking smaller ones preferable, in giving his reasons for his opinion he also assumes that the requirements of the coal trade should settle the question. He says: "While uniformity is a desirable thing in such matters, I do not think it would be just to those most interested in the development of the coal trade on the Cumberland River to build larger locks than they desire, especially as it would delay and increase the cost of the work."

The act of Congress of September 19, 1890, provided for the expenditure of $50,000 at Smith Shoals, subject to the approval of the Secretary of War. The great coal region on the Cumberland is above these shoals, and it is estimated that the construction of some seven locks at these shoals would connect that region with the Cumberland at Burnside, just at the crossing of the Cincinnati Southern Railroad. Below this point the Cumberland is navigable for at least four months of the year. The building of these seven locks will certainly tend to the development of the coal trade as much as the construction of the same number of locks just above Nashville, and therefore, in view of the language of the last appropriation act, I recommended that the $50,000 be expended as indicated in the act. This recommendation was approved, and a careful survey of the river from the first shoal below Burnside to the head of Smith Shoals will be made, as well as observations made to determine the volume and velocity of the current at the various stages of the river and examination for lock sites, etc. It is proposed when lock sites have been definitely determined to take proper steps for securing the necessary land.

A lock and dam constitute an obstruction to navigation which is only justifiable when their aid to navigation more than counterbalances their injury. The locks alone are no obstruction. The dams should not be built until they are required as an aid to navigation, which will not be until after more than a half-dozen locks are built. By this plan the river will be unobstructed with dams until their construction will be an immediate benefit, and for these years the improvement is saved the expense of maintaining lock-keepers and the wear and tear on lock machinery and the dams. It is proposed to prosecute work simultaneously on as many locks as the available funds will permit.

If an appropriation of $500,000 was made for this improvement every other year for the next twenty-eight years its completion could be expected in a little more than thirty years from now. During this thirty years, if nothing is done for the river excepting the building of the locks and dams, navigation, instead of being improved, will, for most of the time, be worse than it is to-day. The permanent improvement of the river by locks and dams will benefit the next generation, but in the meanwhile the present generation should not be overlooked. In my opinion not less than $5,000 a year—and special circumstances may require a larger amount some years—should be expended on this part of the Cumberland River, over 300 miles in length, in building and repairing temporary dams, in snagging, and other necessary work. I do not estimate for this separately, as it is so small compared with the amount that should be appropriated for the improvement.

As Congress has indicated by its designating $50,000 for starting the work at Smith Shoals that it desires the work to be carried on there as well as at the locks immediately above Nashville, provided there are no serious engineering objections, it is proposed in the future to prosecute the work from both points at as many locks as the funds available will permit. It would seem better to treat all the locks as one improvement, and not to limit a part of the appropriation. It is possible that complications about obtaining a suitable site, or other causes, might leave one portion of the river with more funds than were necessary, while the other part was suffering for the lack of money on account of the appropriation being divided.

Four contracts were in force during the fiscal year: (1) Holmes & Wilk, May 30, 1891, for construction of abutment of Dam No. 1; contract completed September 2, 1892. Total amount paid, $11,546.40. (2) Holmes & Wilk, September 19, 1888, for construction of masonry of Lock No. 1; contract completed October 26, 1892. Total amount paid, $91,116.80. (3) Henry F. Holmes, October 17, 1890, for completion of masonry of Lock No. 1; contract in force at close of fiscal year, the date of final completion being December 31, 1893. Amount paid to date, $4,678.20. (4) Rich & Holmes, February 24, 1891, for excavation of lock pit and construction of masonary, etc., of Lock No. 2. In reference to this contract it is stated in the last Annual Report that—

> The time for the completion of this lock was stated to be on or before August 24, 1892. The specifications state that "excavation will be carried 7 feet, and probably in places 10 feet, below the low-water pool No. 1," and that the foundation "shall be excavated to solid rock." Borings show some irregularities, the average depth of rock below the surface of low water in pool No. 1, at a point close to the dam, being 4 feet, and 300 feet below the dam, 9 feet.
>
> Actual operations establish the fact that solid rock can not be found throughout the lock pit at anything like the depths specified, and as the masonry must not be permitted to rest upon the insecure foundation of rock slabs, loose rock, gravel, sand, clay, etc., existing at the specified depths, it became obligatory that the contract be modified to meet the actual conditions and character of the site, it being evident that the contractors could not be required to do the work except in accordance with a supplemental agreement. Such agreement or modification requires the consent of the sureties of the contract. In this case one of the sureties is dead, and the executors of his estate are not willing to grant consent to any modification of the contract of Rich & Holmes.
>
> Under date of May 21, 1892, it was recommended that the contract be terminated under the provisions permitting a termination "for sufficient cause" during the life of the contract without liability on the part of the United States upon payment to the contractor for all work done and all material furnished. This recommendation was approved by the Secretary of War June 3, 1892, with instructions to execute supplemental articles covering a termination of the contract under the provisions of the contract.

Supplemental articles were entered into August 8, 1892, and under their terms the contract was terminated and closed August 19, 1892. Total amount paid, $42,031.36.

The following statement shows the price for each class of work done under the above-named contracts, excepting that for Lock 2; at this lock no masonry was laid and all the work done under this contract consisted of the building of cofferdam, grubbing, and clearing, and earth and rock excavation, at an aggregate cost of $21,756.50; the cost of materials, plant, etc., purchased by the United States amounting to $20,274.86.

*Contracts in force, Cumberland River above Nashville, Tenn., during the fiscal year ending June 30, 1893.*

| No. | Names and addresses of contractors. | Cofferdam. | Excavation, lock-pit. |  | Lock construction, masonry. |  |  |  |  |  |  |
|---|---|---|---|---|---|---|---|---|---|---|---|
|  |  |  | Earth. | Rock in place. | Backing. | Rock face. | Pointed face. | Bush hammered face. | Quoins. | Coping, fine pointed. | Bolt holes. |
|  | *Lock No. 1.* |  |  |  |  |  |  |  |  |  |  |
|  |  | *Per lin. ft.* | *Per cu. yd.* | *Per cu. yd.* | *Per cu. yd.* | *Per cu. yd.* | *Per cu. yd.* | *Per cu. yd.* | *Per cu. yd.* | *Per cu. yd.* | *Per lin. ft.* |
| 1 | Holmes & Wilk, Nashville, Tenn | $5.75 | $0.50 | $1.15 | $8.25 | $11.00 | $12.00 | $14.50 | $30.00 | ....... | $1.50 |
| 2 | Henry F. Holmes, Nashville, Tenn | ....... | ....... | ....... | 8.50 | 11.00 | 12.00 | ....... | 30.00 | $16.00 | 1.50 |
|  | *Abutment, Dam No. 1.* |  |  |  |  |  |  |  |  |  |  |
|  | Holmes & Wilk, Nashville, Tenn | ....... | .30 | 1.25 | 7.50 | 10.00 | 11.00 | ....... | ....... | ....... | ....... |

The amount expended to the close of fiscal year ending June 30, 1892, including outstanding indebtedness, but not the amount pledged by existing contracts, was $143,039.26, which has been applied in the examination and purchase of lands for sites of locks and abutment of dams, and fencing United States lands at Locks Nos. 1 and 2; advertising, etc, for proposals for lock work; construction of lock-keepers' house No. 1; and excavation of lock-pits and building of cofferdams at Locks Nos. 1 and 2; laying about 37 per cent of the masonry of Lock and abutment No. 1. Made survey of upper approach to Lock No. 1 and test borings at site of Lock No. 2; examined land for site of Lock No. 3; ran check line of levels from Lock No. 1 to Locks Nos. 2 and 3, and also to Gallatin Landing for selecting site of Lock No. 4; made detached plans of lock masonry, and constructed models of lock and abutment of Dam No. 1; rebuilding snag boat *Weitzel* and refitting same with pumping and hoisting engines, derrick, etc; clearing the channel below Burksville of snags and other surface obstructions brought down by the annual floods; reducing rock and gravel bars; extending and repairing riprap dams to maintain the improvements already secured; this channel work being done from August to November, 1888, and from March to May, 1889, each inclusive; and the contingencies pertaining to the entire work.

During the present fiscal year, the abutment of Dam No. 1 was finished; 3,040 cubic yards of earth and 14 cubic yards of rock being removed, and 697.4 cubic yards of masonry laid.

The contract for part construction of masonry of Lock No. 1 of September 19, 1888, was completed. Under this contract and that of October 17, 1890, still in force, the following work was done at Lock No. 1: 1,155.3 cubic yards of earth and 439.4 cubic yards of rock were removed and 2,487.5 cubic yards of masonry laid.

No work was done under the contract for building Lock No. 2. The cofferdam had been built and excavation for the lock chamber begun in 1891, but owing to the doubtful character of the site, operations were discontinued and contract terminated as above stated. A thorough reëxamination of the site by a series of test borings is necessary, which will be made as soon as practicable, including the completion of surveys already begun of other locations below the present site deemed suitable for the location of Lock 2, provided it should be held obligatory to abandon its at present selected site.

Detailed surveys of several localities were made during the year from which to select the sites for Locks and Dams Nos. 3 and 4. The report on sites selected for these locks was submitted to the Chief of Engineers, February 13, 1893, and approved, February 16, 1893. The site of the Lock and Dam No. 3 is at Buttermilk Shoals, and that of Lock and Dam No. 4 is at Bandy Shoals immediately above the mouth of Station Camp Creek, about 26 miles and 45 miles above Nashville, respectively.

Land for the site of abutment Dam No. 3, 4.17 acres, was purchased at a cost of $208.50 and title conveyed to the United States by deed dated May 18, 1893. Proceedings in condemnation were instituted by the United States to acquire the lands required for sites of Locks Nos. 3 and 4 and of abutment of Dam No. 4, but no final action thereon was reached at the close of the fiscal year.

A dredge that had seen some service was purchased in October for general use and its machinery transferred to a new hull at a total cost of about $4,500, as authorized.

The lumber necessary for the construction of the cofferdams, barges and temporary buildings, and the vitrified bricks for use in lock construction, also hoisting engine, rails for tramways, and a large part of the plant on hand were moved to the sites of Locks Nos. 3 and 4, while the stage of water permitted, so that active operation would be possible as soon as the title to the sites of said locks was fully vested in the United States.

Lieut. Col. Henry M. Robert, Corps of Engineers, my predecessor in charge, reports to the Chief of Engineers under date of March 25, 1893, that—

> After a somewhat careful investigation of the subject, I am satisfied that the work can be done by hired labor and purchase in open market as cheaply as by contract, beside accomplishing the work in one or two years less time on each lock. I would expect to have all the dimension stone quarried and cut by contract, except the undressed stone recently purchased and now on hand, and such as we may find can be gotten out to advantage at the two quarries which we had to take off the hands of the contractors for Lock No. 2. The backing, I think we can get to better advantage at Chadwell's quarry, now controlled by the United States.
>
> It would be advisable, therefore, to have authority to do the entire work by hired labor and purchase of materials in open market, provided, however, that the dimension stone, in whole or in part, may be contracted for, if deemed hereafter advisable by the engineer officer in charge.

The authority sought, as above stated, was granted March 28, 1893. Under its provisions advertisements were issued June 20, 1893, inviting proposals for supplying 7,912 cubic yards cut stone, as classified in specifications, for building locks on the Cumberland River, the bids to be opened on July 11 next.

The snagging operations begun in June, 1892, by derrick and quarter boats dropping downstream with the current, were continued until the end of October, clearing the channel of surface obstructions from Neelys Shoals to Nashville. In some localities where the snags were very numerous only 10 or 11 miles were made per week.

The work done was as follows:

| | | |
|---|---|---|
| Snags removed | | 739 |
| Snags topped | | 3,045 |
| Overhanging trees cut down | | 7,235 |
| Trees deadened | | 560 |
| Trees topped | | 208 |
| Buoys placed on dams to mark location in high water | | 8 |
| Rock excavated | cubic yards.. | 64 |
| Rock placed in dams | do.... | 14 |

At Holleman Island Shoals the cross dam extending from left bank to island was removed and the dam rebuilt from the island to the right bank, thus carrying the chute to the left bank. The new chute was thoroughly cleared of snags, etc. The small dam near the head of chute was also removed. About 900 cubic yards of rock were moved from the old cross dam to the new dam. About 43 cubic yards of loose rock, 900 cubic yards of gravel, 223 snags and 100 overhanging trees were removed from channel at this obstruction.

The snagging party was in local charge of Mr. W. T. Dodd, and the work at Holleman Island in local charge of Mr. W. H. Carroll.

*Smith Shoals.*—By act of September 19, 1890, Congress provided that of the general appropriation for improving Cumberland River above Nashville, $50,000 may be expended in commencing the improvement at Smith Shoals, and by act of July 13, 1892, provided that $5,000 of a like general appropriation may be used "in the improvement of the river above the town of Burnside." It was recommended and approved that these sums be applied in making the necessary surveys to determine the sites of the locks and dams required "above Burnside," or for the Smith Shoals system of lockage, consisting of seven locks and dams, as projected.

The maps on hand not containing data sufficient in detail for the purpose of selecting the sites of any of the locks, a survey party was organized, and on July 25 an examination was begun of the river from Burnside to the mouth of Rockcastle River, and the results have nearly all been platted on a suitable scale. Observations to determine the discharge of the river at different stages have been made. Gauge readings were taken daily during the winter and spring at six different stations. Examinations in detail have been in part completed for the proposed sites of the first two locks in the series, and are now in progress.

The amount expended during the fiscal year, including outstanding indebtedness, but not including the amount pledged under contract, was $119,294.70; of which $5,773.44 was expended at Smith Shoals.

The field and office work, pertaining to the surveys of the sites for locks and dams, forming part of the project for canalization of the Cumberland River from the mouth of Harpeth River on the lower Cumberland to the head of Smith Shoals, including the work of lock construction in progress at Lock No. 1, near lower Nashville Island, and the preparatory work necessary for an active prosecution in the near future of the construction of Locks and Dams Nos. 3 and 4, have been and are now in local control of Mr. J. S. Walker, principal assistant engineer in this engineer district, whose efficient management is deemed worthy of commendation.

| | |
|---|---|
| Estimate for improving Cumberland River by locks and dams from Nashville to head of Smith Shoals, as modified in 1891 | $7,500,000.00 |
| Amount appropriated | 775,000.00 |
| Amount expended, including outstanding indebtedness and amounts covered by contract | 316,940.89 |

*Money statement.*

| | | |
|---|---|---|
| July 1, 1892, balance unexpended | | $383,417.11 |
| Amount appropriated by act approved July 13, 1892 | | 250,000.00 |
| | | 633,417.11 |
| June 30, 1893, amount expended during fiscal year | | 93,983.25 |
| July 1, 1893, balance unexpended | | 539,433.86 |
| July 1, 1893, outstanding liabilities | $25,311.45 | |
| July 1, 1893, amount covered by uncompleted contracts | 56,063.30 | |
| | | 81,374.75 |
| July 1, 1893, balance available | | 458,059.11 |
| Amount (estimated) required for completion of existing project | | 6,725,000.00 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895 | | 1,000,000.00 |
| Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893. | | |

### 3. CUMBERLAND RIVER, ABOVE MOUTH OF THE JELLICO, KENTUCKY.

Two appropriations have been made for this section of the river, aggregating the sum of $15,000, viz:

| Act of— | |
|---|---|
| March 3, 1881 | $10,000 |
| August 2, 1882 | 5,000 |

No work has been done since 1882 on this section. (See Report of Chief of Engineers, 1882, p. 1846.) The appropriation of $5,000, made by act of August 2, 1882, and held over and unexpended, was made available by the act of September 19, 1890, for expenditure, and to be "applied to the removal of snags and sand bars in the said Cumberland River above Nashville, Tenn."

The sum of $5,000 has been so expended; in 1891, $3,374.46; in 1892, $1,547.56; and during the present fiscal year, $77.98. For work done see Reports of Chief of Engineers, 1891, pp. 2272, 2273 and 1892, p. 1935.

*Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $77.98 |
| June 30, 1893, amount expended during fiscal year | 77.98 |

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COMMERCIAL STATISTICS.

*List of steamboats (stern-wheel) plying on Cumberland River, Tennessee and Kentucky.*

| Name. | Length. | Breadth. | Depth. | Net tonnage. |
|---|---|---|---|---|
| | *Feet.* | *Feet.* | *Feet.* | |
| Ashland City | 120 | 20 | 3 | 94.55 |
| Alex Perry | 149.9 | 28.5 | 3.5 | 172.76 |
| A. Frank | 98 | 18 | 4 | 70.56 |
| B. S. Rhea | 165 | 27 | 4.6 | 203.77 |
| Chas. A. Blackman | 61 | 18 | 3.6 | 25.20 |
| Eleanor | 63 | 16 | 3.4 | 33.87 |
| Ella | 80 | 16 | 3 | 22.82 |
| I. T. Rhea | 149.8 | 30.4 | 3.9 | 198.54 |
| John T. Carson | 85 | 18.8 | 3 | 47.60 |
| John Fowler | 140.5 | 20 | 3.5 | 237.89 |
| J. J. Odil | 149.5 | 28.5 | 3 | 172.76 |
| John Orm | 95 | 17 | 3.5 | 95.33 |
| Jas. R. Skiles | 68 | 17.9 | 3.1 | 41.43 |
| John W. Hart | 168 | 29 | 3 | 215.97 |
| O. E. Stockell | 103.6 | 20.3 | 3 | 169 |
| Raymond | 102.6 | 22 | 3 | 45.16 |
| W. K. Phillips | 166 | 30 | 4 | 195.06 |

SUMMARY.

Permanent enrolled steam vessels, port of Nashville, Cumberland River, Tennessee and Kentucky: 17 vessels of an aggregate net tonnage of 1,942.27 tons—4 ranging from 5 tons to 50 tons, 4 ranging from 50 tons to 100 tons, 6 ranging from 100 tons to 200 tons, 3 ranging from 200 tons to 300 tons.

COMMERCIAL STATISTICS.

*Cumberland River below Nashville, Tenn., from July 1, 1892, to June 30, 1893.*

| Articles. | Tons. | Articles. | Tons. | Articles. | Tons. |
|---|---|---|---|---|---|
| Logs | 40,000 | Stone | 5,450 | Hay | 691 |
| Iron | 29,934 | Tobacco | 5,056 | Salt | 617 |
| Grain | 18,715 | Bricks | 3,205 | Coal | 538 |
| Wood | 11,000 | Horses and mules | 2,037 | Shingles | 131 |
| Sand | 8,400 | Hogs | 1,400 | Hoop poles | 101 |
| Staves | 6,975 | Cattle | 791 | Cotton | 1 |
| Lumber | 6,037 | Flour | 750 | General merchandise | 21,043 |

Number of passengers, 11,906.

*Cumberland River above Nashville, Tenn., from July 1, 1892, to June 30, 1893.*

| Articles. | Tons. | Articles. | Tons. | Articles. | Tons. |
|---|---|---|---|---|---|
| Sand | 38,300 | Wood | 1,600 | Hay | [illegible] |
| Logs | 19,000 | Flour | 1,588 | Horses and mules | [illegible] |
| Lumber | 10,022 | Tobacco | 1,345 | Sheep | 31 |
| Grain | 3,372 | Hogs | 1,251 | Shingles | 82 |
| Staves | 2,000 | Bricks | 1,550 | Iron | 10 |
| Salt | 1,701 | Cross-ties | 300 | General merchandise | 16,550 |
| Cattle | 1,605 | Coal | 350 | | |

Number of passengers, 6,775.

*Cumberland River above Nashville, Tenn., above Burnside-Smith Shoals, from July 1, 1892, to June 30, 1893.*

| Articles. | Tons. | Articles. | Tons. |
|---|---|---|---|
| Logs | 18,000 | Coal | 2,440 |
| Cross-ties | 12,000 | Staves | 30 |

## D D 7.

## IMPROVEMENT OF CANEY FORK RIVER, TENNESSEE.

The Caney Fork River rises in the plateau of the Cumberland Mountains, about 18 miles East of Sparta, Tenn., and discharges into the Cumberland River at Carthage, about 116 miles above Nashville, and 209 miles below Burnside, Ky. This stream is about 200 miles long and has its course and watershed wholly in Tennessee and is navigable to Frank Ferry, about 92 miles from its mouth. Under the provisions of act of Congress approved June 18, 1878, an examination was made in February, 1879, from the mouth of the river to Sligo Ford, 72 miles. (See Report of Chief of Engineers, 1879, pp. 1275–1277.) In compliance with provisions of act of Congress approved July 5, 1884, the examination of 1879 was extended in 1886 from Sligo Ford to Frank Ferry, a distance of 20 miles. (See Report of Chief of Engineers, 1887, pp. 1768–1771.) During these examinations the channel was found to be obstructed by rock reefs, sand and gravel bars, snags, and overhanging trees.

The fall from Frank Ferry to mouth of river, 92 miles, was estimated to be about 132½ feet; 62½ feet of which is in the upper 20 miles.

The present project, based on the data obtained during these examinations, is to improve the 92 miles of river from Frank Ferry to its mouth by removing the surface obstructions brought down by the annual floods and building necessary riprap dams and training walls, so as to obtain sufficient water for safe navigation for steamboats drawing not more than 3 feet during the usual boating season of about five months, from February to July.

The following appropriations have been made for this work by the acts of Congress, viz:

| Act of— | | Act of— | |
|---|---|---|---|
| June 14, 1880 | $6,000 | August 11, 1888 | $2,500 |
| March 3, 1881 | 4,000 | September 19, 1890 | 2,500 |
| August 2, 1882 | 4,000 | | |
| July 5, 1884 | 3,000 | Total | 25,000 |
| August 5, 1886 | 3,000 | | |

No appropriation was made for this river by the act of July 13, 1892.

The amount expended to June 30, 1892, including outstanding indebtedness, was $24,966.62, which was used in removing the snags and drift brought down by the annual floods, cutting overhanging trees, reducing sand and gravel bars, repairing and building wing dams, etc., and has resulted in securing an improved channel from Frank Ferry to the mouth of river. The work done in clearing the channel will be of great advantage to rafts and flatboats coming down on the so-called "rain tides." The amount expended during this fiscal year, $33.38, was on account of current authorized expenses. No channel work has been carried on since August, 1891, the available funds being exhausted. The engineer property pertaining to this work is placed with other property in charge of watchmen on the Cumberland River as a measure of economy and safety.

A small outlay is absolutely necessary in each year for the removal of snags, drift, and other surface obstructions brought down by the annual floods, as is common to the mountain streams of this section, and thus to maintain the channel in a safe navigable condition.

No trips were made during the fiscal year by the three small steamboats that usually ply at irregular intervals on the Caney Fork River during the season of navigation. As stated in the last annual report—

> The commerce, however, has consisted, as heretofore, of logs, and lumber in rafts, but the merchants state that rafts reach them made of logs from the Cumberland River and its several tributaries, and that they have no means whereby to report separately the number of logs or rafts received from the Caney Fork River.

| | |
|---|---|
| Estimate for improving Caney Fork River from its mouth to Frank Ferry.. | $45,228 |
| Amount appropriated | 25,000 |
| Amount expended, including outstanding liabilities | 25,000 |

### *Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $53.38 |
| July 30, 1893, amount expended during fiscal year | 33.38 |
| July 1, 1893, balance unexpended | 20.00 |
| July 1, 1893, outstanding liabilities | 20.00 |
| Amount (estimated) required for completion of existing project | 20,228.00 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895 | 20,228.00 |

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

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*List of steamboats (stern-wheel) plying on Caney Fork River.*

| Name. | Length. | Breadth. | Depth. | Net tonnage. |
|---|---|---|---|---|
| | *Feet.* | *Feet.* | *Feet.* | |
| Alex Perry | 149.0 | 28.5 | 3.5 | 172.76 |
| Pearl | 140.0 | 22.0 | 2.7 | 73.98 |
| J. J. Odil | 149.5 | 28.5 | 3.0 | 172.76 |

## D D 8.

## PRELIMINARY EXAMINATION OF OHIO RIVER BETWEEN LIVINGSTON POINT AND THE HEAD OF TENNESSEE ISLAND, WITH THE VIEW OF PROTECTING THE HARBOR AND MARINE WAYS AT PADUCAH, KY.

[Printed in House Ex. Doc. No. 107, Fifty-second Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
*Washington, D. C., December 5, 1892.*

SIR: I have the honor to submit herewith a copy of report dated August 23, 1892, by Lieut. Col. Henry M. Robert, Corps of Engineers, of the results of a preliminary examination of Ohio River between Livingston Point and the head of Tennessee Island with the view of protecting the harbor and marine ways at Paducah, Ky., made to comply with provisions of the river and harbor act approved July 13, 1892

It is the opinion of Lieut. Col. Robert, concurred in by this office, that the locality is not worthy of improvement by the General Government.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
*Brig. Gen., Chief of Engineers.*

Hon. S. B. ELKINS,
*Secretarg of War.*

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### REPORT OF LIEUT. COL. HENRY M. ROBERT, CORPS OF ENGINEERS.

ENGINEER OFFICE, U. S. ARMY,
*Nashville, Tenn., August 23, 1892.*

GENERAL: I have the honor to submit herewith the following report of a preliminary examination of the "Ohio River between Livingston Point and the head of Tennessee Island with the view of protecting the harbor and marine ways at Paducah, Ky.," made under the provisions of the river and harbor act of July 13, 1892.

The Tennessee and Ohio rivers are nearly parallel just above their junction, the narrow peninsula separating them being known as Livingston Point. About three-fourths of a mile below the point begins Tennessee Island, which is about 2 miles long and forms the protection to Paducah Harbor. Below Tennessee Island is a large bar, so that vessels have to go below this bar to enter the harbor from the Ohio, unless they enter through the opening between Livingston Point and Tennessee Island.

The advantage to be gained by closing this gap is that the junction of the Ohio and Tennessee will be moved some miles down the river to below Paducah, so that its harbor will be kept warmer in winter and hence freer from ice. The marine railway would thus be insured from being ever interfered with by the ice.

Parties interested in the shipping learning that I was in Paducah protested vehemently against the filling up of the gap between Tennessee Island and Livingston Point, claiming it would greatly damage Paducah. I found the lumber interests thoroughly opposed to the so-called improvement, as it would cut them off from the Cumberland and Ohio rivers for their supplies of logs, as the rafts would have to go below Paducah in the Ohio and then be towed several miles up the Tennessee to about opposite the gap where the mills are situated. The way rafts are made up, I understand, makes this impracticable. Now boats going up the Ohio on leaving Paducah usually go through this gap.

The width of this gap is about the same as the width of the Ohio, and the cost of closing it would be very large. I do not know the average depth of water in this gap, but as the river rises from 40 to 50 feet the dike to close the gap would probably have to be 50 feet high and, say, 4,000 feet long. * * * Judging from what I saw in Paducah the "improvement" would meet with more opposition than favor from those affected by it. My own opinion is that the benefits to be derived from this improvement do not justify its great cost and the injury that would result to the lumber and navigation interests.

By these reasons I am led to report that solely for the protection of the harbor and marine ways at Paducah, Ky., the "Ohio River between Livingston Point and the head of Tennessee Island" is not worthy of improvement by the General Government.

There is hereto appended a copy of the protest against the so-called "improvement," signed by some of the most prominent citizens of Paducah, including among others owners and masters of steamboats, manufacturers, the postmaster, the surveyor of customs, the publishers of the Daily Standard, and two of the officers of the Paducah Marine Railway Company.

Very respectfully, your obedient servant,

HENRY M. ROBERT,
*Lieut. Col. of Engineers.*

Brig. Gen. THOMAS L. CASEY,
*Chief of Engineers, U. S. A.*

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PROTEST OF CITIZENS OF PADUCAH, KY.

PADUCAH, KY., *August 16, 1892.*

DEAR SIR: During your late visit to this city we were greatly surprised to learn that you had been directed by an act of Congress to make a preliminary survey of that portion of the Ohio River between Livingston Point and the head of Tennessee Island, with a view of closing the chute between those points for the purpose of protecting the harbor and marine ways at Paducah.

We can not conceive who could have recommended such an unwise measure to Congress, and feel well assured that such recommendation was made, no matter by whom, under a misapprehension of what is needed for the Paducah Harbor.

The closing of that chute, besides costing a vast sum of money, would be a direct and great injury to the manufacturing and commercial interests of Paducah, and would also be a serious hindrance and interference with the navigation of the Ohio and Tennessee rivers in this vicinity. We hope, therefore, that you may find it consistent with your own views, as well as with the facts you ascertained upon your late visit here, to recommend the total abandonment of the project.

The best thing for the protection of the Paducah Harbor, in our judgment, would be the completion of the work already begun at Livingston Point, so as to prevent any further abrasion or washing away of that peninsula.

We have the honor to be, very respectfully,

J. H. Fowler, master of steamboats; J. C. Cobb, master of steamboats; Fowler, Crumbaugh & Co., steamboat owners; Fowler Wharf Boat Company, wharf-boat owners; S. A. Fowler, secretary Commercial Club; J. H. Ashcraft, agent St. Louis and Tennessee River and Nashville and Paducah Packet Companies; T. H. Puryear, L. M. Richs, Ed. P. Noble & Co., wholesale grocers; St. Bernard Coal Company; L. J. Rouse, E. Farley, manufacturer; E. Farley, postmaster; Dieday & Vansendry, publishers Daily Standard; Ambrook & Rowell, insurance and real estate agents; R. J. Rouse, Langstaff-Orm Manufacturing Company, manufacturing lumber, sash, doors and blinds; H. M. Orme, member city council; John R. Puryear, surveyor of customs, Paducah, Ky.; Paducah Marine Railway Company, Wm. Hughes, secretary and treasurer; H. H. Graber, superintendent marine railways; Chas. Reed, ex-mayor of Paducah.

Col. HENRY M. ROBERT,
*United States Engineer Corps.*

## D D 9.

## PRELIMINARY EXAMINATION OF DUCK RIVER, TENNESSEE.

[Printed in House Ex. Doc. No, 33, Fifty-second Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
*Washington, D. C., December 5, 1892.*

SIR: I have the honor to submit the accompanying copy of report dated October 7, 1892, by Lieut. Col. Henry M. Robert, Corps of Engineers, of the results of a preliminary examination of Duck River, Tennessee, made under his direction to comply with provisions of the river and harbor act approved July 13, 1892.

I concur in the views of Lieut. Col. Robert that Duck River is worthy of improvement by the General Government. He states that an estimate of cost of improvements proposed can be furnished without making a new survey.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
*Brig. Gen., Chief of Engineers.*

Hon. S. B. ELKINS,
*Secretary of War.*

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## REPORT OF LIEUT. COL. HENRY M. ROBERT, CORPS OF ENGINEERS.

ENGINEER OFFICE, U. S. ARMY,
*Nashville, Tenn., October 7, 1892.*

GENERAL: I have the honor to submit herewith the following report of the preliminary examination of the Duck River, Tennessee, made under the provisions of the river and harbor act of July 13, 1892:

First Lieut. John Biddle, Corps of Engineers, was detailed to make the preliminary examination, and his report is appended hereto.

In 1879 Assistant Engineer D. L. Sublett, under the direction of Maj. W. R. King, made quite a thorough examination of the Duck River below Centerville, a distance of 68.5 miles. (See Report of Chief of Engineers, 1880, pp. 1681–1687.) The fall in this distance was found to be 122 feet. Above Centerville the river has not been deemed capable of improvement at any justifiable cost. Below Centerville, Major King estimated the river could be made navigable for half the year at an expense of $35,000, and when $13,000 were appropriated and expended he reported the river "in a fair navigable condition from Centerville to its mouth," and that "although the work contemplated in the existing project has not all been done, it is believed that the improvement accomplished will answer all the present needs of commerce, for several years at least." (See Report of Chief of Engineers, 1893, p. 1488.)

Since December, 1882, no work has been done on the river, and consequently it is again badly obstructed with snags and overhanging trees.

Lieutenant Biddle states that "the real demand for improvement is only for the last 20 miles of the river, up to the foot of Hackle Shoal, and especially from the mouth of Buffalo River down, 17 miles." He examined this portion of the river and is of opinion that the river is worthy of improvement from the foot of Hackle Shoal to its mouth.

* * * * * * *

One general map of the river from Centerville to the Tennessee River and thirty-eight detailed sketches of the principal obstructions were made in connection with the examination of 1880, so that there is no need of a further survey at present.

* * * * * * *

The Duck River runs through an exceedingly rich agricultural country, the resources of which are described in the report of the examination made in 1880. The commerce on the river is but slight, only one steamboat navigating it at present, and that only ascending the river 10 or 12 miles. The proposed improvement, it is thought, will develop this commerce.

Based on the aforementioned facts and statements, I am of opinion that the Duck River, Tennessee, is worthy of improvement by the General Government.

Very respectfully, your obedient servant,

HENRY M. ROBERT,
*Lieut. Col. of Engineers.*

Brig. Gen. THOMAS L. CASEY,
*Chief of Engineers, U. S. A.*

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## REPORT OF LIEUT. JOHN BIDDLE, CORPS OF ENGINEERS.

SEPTEMBER 17, 1892.

COLONEL: I have the honor to submit the following report of a preliminary examination of the Duck River, Tennessee:

The Duck River rises in the plateau of the Cumberland Mountains, in the eastern part of middle Tennessee, flows somewhat north of west through the center of the State, and empties into the Tennessee River. The highest point to which it has been considered navigable is Centerville, 68.5 miles above the mouth.

The river was examined from Centerville down in 1879 (Report of Chief of Engineers, 1880, p. 1681.) Attention is invited to this report. The estimate for improvement was $35,118. Ten thousand dollars were appropriated and the river partially improved over the whole distance mentioned. Since 1883 no work has been done. The work in the upper part of the improved river, where most of the appropriation was expended, has not caused any development of navigation and is not likely to for the present.

To make the examination, I left Nashville September 14; proceeded to Johnsonville, which is the point of transfer to the railroad of the Duck River commerce. I obtained all the information possible from the owner of the only steamboat plying the river and from other inhabitants interested. Then, with a pilot, I went over the river from Hurricane Creek to the mouth, about 20 miles. A description of the river with its shoals, etc., is given in the report above mentioned.

The channel is shifting. The banks are cutting badly almost the whole length gone over. Trees are falling in the water at places, but as a rule where the bank is now cutting there are few trees. There are many snags.

The only steamboat navigating to-day is the *Wyandot*, 90 by 18 feet, and loading down to 2¼ or 3 feet. During the last season she carried out 16,000 sacks of corn, 200,000 oak staves, and one load of hickory spokes. The first trip was made January 8 and the last May 2, 1892. Four thousand sacks of corn were carried out by another steamer. A number of lumber rafts are brought down the river. The *Wyandot* ascended the river only about 10 or 12 miles. Boats can carry only small loads when navigating Duck River, and it does not pay them to go far upstream, even when possible, as it is very often the case.

The real demand for improvement is only for the last 20 miles of the river, up to the foot of Hackle Shoal, and especially from the mouth of Buffalo River down, 17 miles. The people along this part of the river, particularly those on the south bank, depend almost entirely on the river transportation. For about 4 or 5 miles up Buffalo River the farmers would probably make use of the Duck River boats if they ran more regularly. They now haul produce to the Tennessee River. It is believed among the inhabitants that more regular boat service would allow the development of other industries, as for staves, hoops, etc.

In view of these facts, I consider that the Duck River is worthy of improvement in its lower course. I do not think that any further survey is necessary. The work I would recommend would be simply the removal of snags and overhanging trees, commencing at the mouth of the river and continuing to foot of Hackle Shoal, about 20 miles. As the number of snags changes, any estimate as to the number would only be accurate during one season, and for that reason a previous survey seems superfluous. If this work causes a development of commerce, further improvements could then be made.

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Very respectfully, your obedient servant,

JOHN BIDDLE,
*First Lieut. of Engineers.*

Lieut. Col. HENRY M. ROBERT,
*Corps of Engineers.*

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## D D 10.

## PRELIMINARY EXAMINATION OF SEQUATCHIE RIVER, TENNESSEE.

[Printed in House Ex. Doc. No. 60, Fifty-second Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
*Washington, D. C., December 5, 1892.*

SIR: I have the honor to submit the accompanying copy of report dated August 23, 1892, from Lieut. Col. H. M. Robert, Corps of Engineers, of the results of a preliminary examination of Sequatchie River, Tennessee, made to comply with the provisions of the river and harbor act approved July 13, 1892.

It is the opinion of Lieut. Col. Robert, concurred in by this office, that the river is not worthy of improvement by the General Government.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
*Brig. Gen., Chief of Engineers.*

Hon. S. B. ELKINS,
*Secretary of War.*

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### REPORT OF LIEUT. COL. HENRY M. ROBERT, CORPS OF ENGINEERS.

ENGINEER OFFICE, U. S. ARMY,
*Nashville, Tenn., August 23, 1892.*

GENERAL: I have the honor to submit herewith the following report of a preliminary examination of the Sequatchie River, Tennessee, made under the provisions of the river and harbor act of July 13, 1892:

The Sequatchie Valley is about 70 miles long and 4 miles wide, running in a southwesterly direction about parallel to the Tennessee River, being separated from it by Waldens Ridge, about 1,200 feet high. The Sequatchie River winds its way down this valley to the Tennessee, which it enters about 3 miles above South Pittsburg.

The hills on either side are exceedingly rich with coal and iron, the coal being mainly on the northwestern side, while the iron is on the opposite side of the valley. The accompanying letters will give some idea of the wealth of this valley.

The drainage area of the Sequatchie is very small because the mountains on either side rise up from the valley almost vertically to their full height, so that the slopes are all from the valley. At Pikeville, 50 miles up the valley, in the driest seasons the river, I understand, is about 30 feet wide and 4 inches deep, giving a cross-section of 10 square feet. At Dunlap, 20 miles by railroad down the valley, the river was, as near as I could judge without measuring, about 100 feet wide, and I was informed it was at least 3 feet deep. For about 4 miles above Dunlap the river maintains this width. I learned from one of the engineers engaged on the railroad survey that it is about 100 feet wide about 12 miles, in a straight line, above its mouth where the railroad from Victoria to the Inman mine crosses the river. Messrs. Myers and Perin in the accompanying paper state that at its mouth it reaches a width of 300 feet, whereas Mr. Smith gives its greatest width at 150 feet.

About a dozen milldams are scattered along the river, about one-half the number being above Dunlap and the other half below.

Through the kindness of Mr. McDonald, assistant engineer Nashville, Chattanooga and St. Louis Railroad, I was permitted to examine the notebooks of the survey for the railroad up the Sequatchie Valley, and thus obtained some idea of the fall of the river. The railroad station at Whitwell is 30.77 feet, the station at Dunlap 103.77 feet, and the station at Pikeville 253.77 feet above the level of the river at the bridge where the Inman Branch Railroad crosses the Sequatchie River, about 12 miles in a straight line above its mouth. The river is assumed to have been at its low-water stage when the level was taken at the railroad bridge August 23, 1882, and the error due to this assumption does not probably exceed 1 foot, as the extreme rise of the river is stated to be about 12 feet.

Low water at the mouth of the Sequatchie is about 3.75 feet above low water at the railroad bridge at Bridgeport, as shown by the Government surveys, and connecting at the latter point with the railroad survey, we find that the fall of the Sequatchie from the railroad bridge to its mouth, a distance of about 12 miles, is about 17.50 feet. I was unable to ascertain the heights of the railroad stations above the adjacent river; but, from the best information obtainable without a special survey, it seems that there is a fall in the river of about 140 feet from Pikeville to Dunlap, a distance of 20 miles by railroad, and a fall of about 70 feet from Dunlap to Whitwell, about 15 miles, and a fall of about 30 feet from Whitwell to the mouth of the river, a distance also of about 15 miles in a straight line.

It is desired that the river be improved up to Pikeville, a distance of 50 miles by land, or at least to Dunlap, about 30 miles by land. The fall from Pikeville to the mouth of the river is about 240 feet, and from Dunlap to the mouth the fall is about 100 feet. Messrs. Myers and Perin state:

> The gradient of the stream from Pikeville, the probable head of navigation, is 6 feet to the mile, ascertained by accurate railway leveling.

More than fifty years ago, it is asserted, flatboats were built on this river, loaded with the products of the country, and floated down the Tennessee, Ohio, and Mississippi to New Orleans, where the freight and boats were sold, and the crews came back as far as Memphis and then footed it across the country home again, supporting themselves along the way by hunting. The State, in 1838, appropriated $5,000 for the improvement of this river, but from what I could learn it probably did as much harm as good. At any rate the river has not been used for many years.

The mineral resources of the valley are so great that the river should be improved if it could be done at any reasonable cost. But from Pikeville to Dunlap, though less than 20 miles by railroad, the river has a fall of about 140 feet, requiring about fourteen locks and dams, while the low-water channel for most of the distance varies from 30 to 60 feet in width, from the best information I can get. The improvement of this portion of the river is unquestionably not worth what it would cost.

Below Dunlap, or probably below Mount Airy, 5 miles above, the river is better, being probably 100 feet and at places 150 feet wide. Still the fall is very great, being 100 feet from Dunlap to the mouth, requiring 10 locks and dams to make this portion of the river navigable. I do not think the large expenditure required for this improvement justifiable.

For the above reasons, notwithstanding the great resources of the valley, I am of opinion that the Sequatchie River, Tennessee, is not worthy of improvement by the General Government.

Appended are the letters of Messrs. Myers and Perin and Benjamin B. Smith, C. E., herein referred to.

Very respectfully, your obedient servant,

HENRY M. ROBERT,
*Lieut. Col. of Engineers.*

Brig. Gen. THOMAS L. CASEY,
*Chief of Engineers, U. S. A.*

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### JOINT LETTER OF MESSRS. G. C. MYERS AND C. P. PERIN.

PIKEVILLE, TENN., *August 11, 1892.*

DEAR SIR: In reply to your verbal request we send you the following facts in regard to the river of the Sequatchie Valley gathered from the most reliable sources:

First. This river flows through the entire length of the valley, about 80 miles, emptying into the Tennessee and rising in the Cumberland Mountains about 20 miles above Pikeville. Its width varies from 50 feet at its source to 300 feet at the point where it empties into the Tennessee River. Its cross section at Pikeville during the driest times is 30 feet wide by 4 inches deep, but the stream gradually gathers strength as it approaches the Tennessee. The gradient of the stream from Pikeville, the probable head of navigation, is 6 feet to the mile, ascertained by accurate railway leveling. The current is ordinarily no swifter than that of the Tennessee River.

The present length of the river following its natural channel is probably 150 miles. The banks are principally of sand or alluvial soil, which will enable the straightening and shortening of the stream to be accomplished at small expense. The average depth of this stream in the channel is 3 feet.

Second. The resources of the valley are chiefly agricultural, the valley proper being from 3 to 5 miles wide its entire length. It is bounded on the east by Waldens Ridge, a mountain 1,200 feet high, and from 12 to 15 miles broad, underlaid with the famous red fossiliferous iron ore, which now supplies the blast furnace of the Tennessee Coal, Iron and Railway Company at South Pittsburg. This mountain further furnishes coal, coke, ore, and limestone for the Rockwood furnaces; also the Dayton furnaces.

Said valley is bounded on the west by the Cumberland range of mountains, 1,100 feet high, and from 25 to 40 miles wide the entire length of the valley, exposing on its escarpment from five to eight veins of coal, one of which is the famous Sewanee coking coal vein.

This Cumberland coal field is practically inexhaustible and contains an area of 5,000 square miles, the product of which will ultimately supply the entire South. This field is accessible all along the Sequatchie Valley. In addition to the above resources we have unlimited quantities of building and paving stones now being worked at Pikeville and distributed along the entire river.

The slopes of these mountains are covered with every variety of timber known in the South. Oak, poplar, ash, walnut, and sycamore abound.

The table-lands upon Waldens Ridge and Cumberland Mountain, under the stimulus of a market and cheap transportation, can be made to produce all varieties of small fruits in luxuriance, as well as vegetables. Of the many other natural resources not mentioned all would be benefited by cheap water transportation such as was enjoyed by the inhabitants prior to the late war.

Very respectfully, your obedient servants,

G. C. Myers.
C. P. Perin.

Col. Henry Martyn Robert, U. S. A.

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### LETTER OF MR. BENJAMIN B. SMITH, CIVIL ENGINEER.

Jasper, *July 29, 1892.*

Dear Sir: Your letter requesting data, etc., in regard to Sequatchie River came duly to hand. Inclosed you will find a short report as to the nature of the river, so far as I can get it from information picked up mainly during the convention, which met at Dunlap early in the spring. Hoping that the inclosed information will be of some service.

The Sequatchie River, more correctly in the Indian Sequachee, takes its rise in the extreme northern end of Sequatchie Valley and following a southerly and somewhat tortuous course of 100 miles or so, empties into the Tennessee River at a point about 3 miles above the town of South Pittsburg, Tenn. It is generally supposed to be a continuance of Lost Creek, made famous by Craddock's stories, which flowing due north on the northern side of the divide, plunges into a mountain and, flowing under itself, emerges on the southern side of the divide, forming the Sequatchie River.

As far back as the 30's the river was extensively used for downstream traffic, taking the produce, mainly wheat, of the rich valley to the Tennessee River, there to meet with barges bound for southern and western ports. Wheat, corn, potatoes, chickens, eggs, spoke and stave timber, and rafts of logs were shipped in abundance on flush stages. An appropriation was made for this river at the same time with other rivers of the State by the State of Tennessee and expended in general channel work. No appropriation has ever been made by the General Government, so far as I can learn.

The project proposed by the convention which met in the spring of 1892 was to slack water as far up as Dunlap, a distance of between 40 and 50 miles.

The river follows the general characteristics of rivers in this section. The banks are for the most part low and the bottoms of considerable extent. Some rocky hills skirt the river in many places on one side or the other. At these points the river is narrow and the bed rocky and channel shallow. The river is obstructed by rock and gravel shoals, in some places the channel being exceedingly narrow where an island obstructs the river. So far as I can learn there are at present three milldams across the river between the mouth and Dunlap; the mills, I believe, are in active operation. The width of the river varies from about 60 to 150 feet. The fall from Dunlap to the Tennessee will probably aggregate in the neighborhood of 60 feet. This fall is mostly confined to the shoal and rocky portions, the valley in the main being exceedingly level, the river flowing for long stretches through alluvial banks which are low, but stable for the most part.

There is practically no commerce at present, what there is being confined to rafting of poplar, with some oak and gum, during high-water seasons.

The object for clearing the river is to reduce the exorbitant freight rates of the Jasper branch of the N. C. & St. L. R. R., which has no competition and charges what it chooses. The traffic of this road is considerable, the main freight being the output of the Inman mines belonging to the Tennessee Coal, Iron, and Transportation Company. There are coal and iron mines also at Dunlap, Sequatchie, and near Jasper. Most of these mines are at present idle, owing to the enormous freight charges.

The river could be made navigable for the greater portion of the year by a combination of snagging and channel work with slack water where the shoals are rocky and the river is wide and shallow.

The mineral resources of the Sequatchie Valley are simply enormous. Coal and iron are found in great abundance, both on the Walden Ridge and the Cumberland Plateau.

In the upper valley considerable wheat, oats, grass, some corn, and cattle are raised. In the lower valley the farming industries are confined to corn cropping, with a little grass and some cattle, chickens, eggs, etc. There is yet some considerable amount of merchantable timber on the upper portions of the river.

Col. Tomlinson Fort, of Chattanooga, is chairman of Sequatchie River improvement committee, and could furnish you with all the names you could desire.

Very respectfully,

**Benj. B. Smith, C. E**

Lieut. Col. **Henry M. Robert,**
*Corps of Engineers, U. S. A.*

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## D D II.

### PRELIMINARY EXAMINATION OF HIWASSEE RIVER, IN TENNESSEE, FROM ITS CONFLUENCE WITH THE TENNESSEE RIVER TO THE MOUTH OF THE OCOEE RIVER.

[Printed in House Ex. Doc. No. 27, Fifty-second Congress, second session.]

Office of the Chief of Engineers,
United States Army,
*Washington, D. C., December 5, 1892.*

Sir: I have the honor to submit herewith a copy of report, dated August 22, 1892, by Lieut. Col. Henry M. Robert, Corps of Engineers, of preliminary examination of Hiwassee River, in Tennessee, from its confluence with the Tennessee River to the mouth of the Ocoee River, provided for by the river and harbor act approved July 13, 1892.

It is the opinion of Lieut. Col. Robert, concurred in by this office, that the river is worthy of improvement by the General Government.

An estimate of $2,000 is submitted as the cost of the survey necessary in order to prepare plan and project with estimate of improvement proposed.

Very respectfully, your obedient servant,

Thos. Lincoln Casey,
*Brig. Gen., Chief of Engineers.*

Hon. S. B. Elkins,
*Secretary of War.*

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### REPORT OF LIEUT. COL. HENRY M. ROBERT, CORPS OF ENGINEERS.

Engineer Office, U. S. Army,
*Nashville, Tenn., August 22, 1892.*

General: I have the honor to submit herewith the following report of a preliminary examination of the "Hiwassee River, in Tennessee, from its confluence with the Tennessee River to the mouth of the Ocoee River," made under the provisions of the river and harbor act of July 13, 1892.

The Hiawassee, or, as it is more commonly written, Hiwassee River, rises in the mountains of the Blue Ridge, in western North Carolina and northern Georgia, whence, flowing in a northwesterly direction, it breaks through the Unaka Range and enters the Tennessee River 36 miles above Chattanooga and 148 miles below Knoxville. The Hiwassee receives the tributary waters of the Ocoee about 12 miles above Charleston and 6 miles below Savannah Ford or Farm, which is held to be the head of navigation. Below the Savannah Farm the Hiwassee is of good capacity for the passage of the flatboats that run above and below Charleston. The Hiwassee River has already received the favorable consideration of Congress, as ten appropriations, aggregating the sum of $36,500, were made from 1876 to 1890, for its improvement. This sum has been expended to the advantage of its commerce and navigation. (See Annual Report of the Chief of Engineers, 1892.)

At present the Tennessee River Transportation Company of Chattanooga has one steamboat plying between Chattanooga and the Savannah Farm, though during high stages of the river the company is compelled to make transfer of freight to another of their boats at Charleston, by reason of the obstructive character of the bridge of the East Tennessee, Virginia and North Georgia Railway at that point, this bridge having no draw.

The Tennessee River Transportation Company reports the moving of 17,628 tons of miscellaneous freight during the year ending June 30, 1892. The Loomis and Hart Manufacturing Company, of Chattanooga, states that about 3,000 tons of logs were received from this river during the same period. To this commerce should be added that brought down by the numerous flatboats and keelboats, the full amount of which it has been impossible to collect, though it is estimated that 150 carloads of grain, besides large quantities of hay and other merchandise, have been thus brought to a market.

In view of these facts it has not been deemed necessary to make an additional examination by actual passage over the entire length of the stream between the points designated. The engineer officer in charge has recently inspected the work in progress at Matthew Shoals, about 13½ miles from the mouth of the river, and the river between that point and Charleston, about 12 miles above.

Based on the foregoing facts and statements relative to its present and prospective commerce, I am of opinion that the "Hiwassee River, from its confluence with the Tennessee River to the mouth of the Ocoee River," is "worthy of improvement by the General Government," and recommend that a survey be made from its mouth to the Savannah Farm, the head of navigation, at a cost of about $2,000, including the expenses incident to the preparation of estimates and submission of a project for the radical improvement of this river between the points last named.

Very respectfully, your obedient servant,

HENRY M. ROBERT,
*Lieut. Col. of Engineers.*

Brig. Gen. THOMAS L. CASEY,
*Chief of Engineers, U. S. A.*

## D D 12.

## PRELIMINARY EXAMINATION OF EMORY RIVER, TENNESSEE, FROM ITS MOUTH TO HARRIMAN.

[Printed in House Ex. Doc. No. 21, Fifty-second Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
*Washington, D. C., December 5, 1892.*

SIR: I have the honor to submit the accompanying copy of report, dated August 22, 1892, by Lieut. Col. Henry M. Robert, Corps of Engineers, of the results of preliminary examination of Emory River, Tennessee, from its mouth to Harriman, made under his direction to comply with provisions of river and harbor act approved July 13, 1892.

Lieut. Col. Robert states that in his opinion Emory River is worthy of improvement by the General Government, provided it can be done at a reasonable cost, which can only be determined by a survey made during low water, for which he submits an estimate of $600.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
*Brig. Gen., Chief of Engineers.*

Hon. S. B. ELKINS,
*Secretary of War.*

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## REPORT OF LIEUT. COL. HENRY M. ROBERT, CORPS OF ENGINEERS.

ENGINEER OFFICE, U. S. ARMY,
*Nashville, Tenn., August 22, 1892.*

GENERAL: I have the honor to forward herewith a report of a preliminary examination of the "Emory River, Tennessee, from its mouth to Harriman," made by First Lieut. John Biddle, Corps of Engineers, in compliance with the river and harbor act of July 13, 1892.

The Emory River enters the Clinch about 4 miles above the point where the latter river enters the Tennessee. Kingston, on the Clinch River, 1 mile above its mouth, has regular steamboat connection with Loudon above and Chattanooga below, both on the Tennessee River. Harriman is on the Emory, about 8 miles from its mouth and within 11½ miles of Kingston, by water; the town extends, with its additions, from Emory Gap down the river for about 3½ miles, and it is said to contain from 4,000 to 5,000 inhabitants and has excellent railroad connections. There are large quantities of iron and coal in its vicinity that would be affected by the improvement of the Emory. The advantages to be derived are fully stated in the letter hereto appended of Mr. James Hayward, assistant manager, to the general manager of the East Tennessee Land Company.

Lieutenant Biddle recommends a survey of the river from the gap, or Harriman, to its mouth.

The existing commerce of the Emory River is now small, but the prospective commerce will be largely increased by the opening up of the iron, coal, and lumber trade incident to an improved river channel.

For the reasons given above I am of opinion that the "Emory River, from its mouth to Harriman," is "worthy of improvement by the General Government," provided it can be done at a reasonable cost, which can only be determined by a survey made during low water, which I recommend to be made at a cost not to exceed $600, including the cost of submitting plan and estimate for its improvement.

Very respectfully, your obedient servant,

HENRY M. ROBERT,
*Lieut. Col. of Engineers.*

Brig. Gen. THOMAS L. CASEY,
*Chief of Engineers, U. S. A.*

### REPORT OF LIEUT. JOHN BIDDLE, CORPS OF ENGINEERS.

AUGUST 6, 1892.

COLONEL: I have the honor to submit the following report of the preliminary examination of the "Emory River, Tennessee, from its mouth to Harriman."

The examination was made from July 23 to 25. I visited the city of Harriman, conversed with persons interested in its commerce, and went over the river in a rowboat. I had the assistance of the chief engineer of the East Tennessee Land Company, Mr. J. P. Suverkrop, who has been at the city since it was first built and is well acquainted with the river. I also discussed the subject with Capt. W. P. Rose, manager of the Emory River Packet Company.

A map* of the river and the country adjacent and a statement of the advantages to Harriman of an improvement in the Emory River, both prepared in the office of the East Tennessee Land Company, are submitted.

On the day of examination the river was about 2 feet above low water, so that the shoals could not be seen as well as if the water had been lower. The low-water depths as given are therefore only approximate, deduced from statements made by well-informed persons and from the depths actually measured. It was impossible at that stage of water even to approximate to the fall.

The Emory River rises in Cumberland County, Tenn., flows through Morgan and Roane counties, crossing Waldens Ridge at Emory Gap, and empties, 11¼ miles below, into the Clinch River 3¼ miles above Kingston. The Clinch joins the Tennessee River about 1 mile below Kingston. The city of Harriman lies on the left bank of the Emory, extending with its additions for about 3¼ miles below the gap.

The highest point to which boats have ascended is said to be the gap. The head of navigation is usually considered as at Webster, formerly Barton Landing, 4 miles farther down, or 7¼ miles above the mouth. The area drained by the Emory River is not large and it is, consequently, subject to sudden rises and falls, and becomes very low in dry weather. The principal tributary is the Little Emory, about 4 miles above its mouth, a small creek that brings but little water at low stages.

The Emory River varies in width from 75 to 100 feet above the Little Emory; it then widens out, and at the mouth is over 200 feet wide. The banks are 15 to 25 feet high, well wooded, and permanent. Bluffs occur from time to time, so that there is plenty of stone for dams. There are many overhanging trees and a few snags.

The point which it is desired to make the head of navigation is below Mees Ferry, 2¼ or 3 miles above Webster. From this point for one-half mile downstream the water forms a pool 100 feet wide with a depth of 3 to 10 feet. Opposite the first branch, called Bullard Branch, is a shoal 600 feet long, with a probable depth of 0.5 to 1 foot, and numerous bowlders. Below the shoal the water deepens, and for 1 mile is good water, with occasional bars and reefs. Then occurs for 1,500 feet a succession of short shoals and pools, with a depth of 0.5 to 1 foot at low water, a narrow channel and numerous bowlders. At the next branch, called Robinson, is a shoal 300 feet long, depth of 6 inches to 1 foot, with numerous bowlders, and one-fourth mile lower down another similar shoal for 100 feet. Below the latter shoal is Webster. From this point to the mouth, 7¼ miles, the water is generally good, except at two places. The first is three-fourths of a mile below Webster, where a short shoal of 50 feet will give a probable depth of 12 to 18 inches, and the second is below the mouth of the Little Emory, where there are some shallow bars and reefs. Over the rest of the river there may have to be removed occasional bowlders, but the water seemed good.

The current, except at the shoals, is very sluggish. The backwater of the Clinch makes itself felt at least as far as Webster.

An examination of the river was made in 1876 by Mr. William M. Gordon, assistant engineer, and published in report of Maj. Walter McFarland, Corps of Engineers. The cost of improvement was estimated at $12,000, but it is stated that no public interest demanded it. (See Report of Chief of Engineers, 1876, p. 745, *et seq.*) Since that date Harriman has been built.. Started in 1890 by the East Tennessee Land Company, it claims now 4,000 to 5,000 people, and has various industries. It has railroad connection with the Cincinnati Southern and the East Tennessee, Virginia and Georgia railroads, and has a belt line called the Harriman Coal and Iron Railroad, extending along the river bank in front of the city. This latter road is in part built out to the Brushy Mountain coal fields, passing close to Webster. These coal fields are said to be very extensive and to give an excellent quality of coal.

At present coal is brought by a trolley from a mine directly across the river from the city. A wagon bridge across the river is contracted for.

A transportation line, called Emory River Packet Company, has two boats that run daily from Kingston to Loudon, Tenn., and also at times to Harriman. It was intended to run regularly to Harriman as long as the river allowed. That it is not done is due, as told me by the manager, to the fact that they can not go above Webster, and the belt line is not yet extended to that point, and to the sudden falls in water, incident to the Emory River, making it dangerous to remain in the river all night. The completion of the belt line and the improvement of the river would, Capt. Rose says, cause the boats to run regularly.

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*Not printed.

The advantages to Harriman of good navigation are given in appended statement. They lie generally in the reduction of rates both for land and water transportation and in affording a better outlet for the products of the Upper Tennessee Valley. More especially would this be the case when the projected furnace is built. Among the best and most abundant ores on the Tennessee River are those from Eureka and adjacent mines, 3 miles above the mouth of the Clinch River, and thus 15 miles from Harriman. If this ore can be brought by barges and worked with Brushy Mountain coal, successful furnaces might be established.

The river likewise would afford an outlet for coal, iron, and other products. Once connected with the Tennessee River, navigation becomes continuous to the Ohio and Mississippi rivers.

Kingston, the county-seat of Roane County, would profit by being brought within 11 miles by water transportation of railroads, while now connection is made with Loudon, 25 miles distant. The principal business of Kingston is lumber and the trade at present is very dull.

If navigation can be obtained at a reasonable cost, I am of the opinion that improvement should be undertaken. I am in doubt whether absolute low-water navigation can be secured by channel work, even up to Webster, and whether farther than that point profitable navigation can be sure at 2 or 3 feet on the gauge. An examination at low water would have to determine these points. Even if the improvement were limited to removing bowlders and cutting trees it would be of advantage. It seems probable that a single lock and dam at Kingston would back up water sufficient to make the Emory navigable. This would, however, be, of course, very expensive, but would be a satisfactory solution.

There is a bar in the Clinch River about one-half mile below the Emory that will have to be removed for low-water navigation. The project of the improvement of the Clinch contemplates, however, a low-water depth of 2 feet, and work is being carried forward on that basis.

I therefore recommend that a survey be made of the Emory River from the gap to its mouth, on which to base project for improvement. This survey will take about two weeks' work and will cost about $600. It should be made in the autumn when the river is more likely to be low.

Very respectfully, your obedient servant,

JOHN BIDDLE,
*First Lieutenant of Engineers.*

Lieut. Col. HENRY M. ROBERT,
*Corps of Engineers.*

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### LETTER OF MR. JAMES HAYWARD.

[East Tennessee Land Company; office of W. H. Russell, general manager; J. D. Roberts, assistant general manager.]

HARRIMAN, TENN., *July 27, 1892.*

In my report to you upon the probable effect of making such improvements in the Emory River as to render that river navigable to Harriman, most, if not all of the year, the limited time at my disposal must be my excuse for any inaccuracies or omissions.

Assuming that such river improvements have been made, I shall first consider the effects on north-bound traffic. The city of Harriman would probably look to the southeast for all its supplies in the way of cereals, hay, and dressed meats, and for most of its vegetables. Our flour mill would draw from the Sweetwater Valley from 75,000 to 100,000 bushels of wheat annually. The local consumption is about 20,000 bales of hay, and the corn, oats, potatoes, and other supplies requisite for meeting the demands of a city of 5,000 inhabitants would collectively amount to a very large tonnage. Further, the natural outlet for the hard-wood lumber business of Kingston would then be by water to Harriman, thence by rail. This trade, on the present basis of business, would require millions of feet of hard wood, and under the stimulus of such advantages, this trade would be doubtless increased considerably. Again transportation would be opened up for a bed of very fine brownstone near Kingston, where for 6 or 8 miles the stratum is exposed, varying from 50 to 100 feet in thickness. This brownstone is rich in color, of even grain, and easily quarried and worked; and has the peculiar merit of growing harder under exposure, a rare quality in this class of minerals, but one which would materially assist in introducing it into general use. As you can see, the possible tonnage of this material is enormous.

But perhaps the greatest advantage to accrue to the city of Harriman from these improvements would be in connection with the iron and coal interests. When our blast furnace is completed, it will require daily for every day in the year, at least 300 tons of ore, or more than 100,000 tons in a year, which should naturally come from our mines now in operation to this place by water. There would also be opened to us cheap transportation for tanbark, Tennessee marble, and a variety of materials needed by our various factories.

Turing now to the other side of the case and considering the advantages of shipping out of this territory by means of water, we discover that a cheap outlet would thus be afforded generally for all our manufactured products, and for all our raw material; and, naturally, because we are in the heart of the territory toward which to-day a large part of the Union now turns to supply itself with coal, coke, iron ore, and the various kinds of lumber and tanbark, it is not too much to say that a rate of freight could then be had from our coal fields to Chattanooga that would be profitable to the navigation company, and yet so low as to be below the cost of handling the same by rail. If this position is correct, it could hardly be two years before cities like Chattanooga would get their coal supplies entirely by water. Furthermore, the cities along the Mississippi River, which now use for making gas the bituminous coals found in our range of mountains, would find us lively competitors with Pennsylvania and West Virginia for their trade; and as we would have an all-water connection between our mines and those cities, it might naturally be expected that we would gain at least our share of the business. The fact that our coal makes a superior quality of coke, the cost of which material is doubled to most places in the Mississippi Valley by reason of the high freights necessarily paid, should enable us to sell large quantities of this material by reason of the relatively cheaper freight rate which water transportation would enable us to get.

Under this rate we would at once find customers in Rockwood, Dayton, Chattanooga, South Pittsburg, and other such places, so that it is upon a careful estimate by our mining expert that we may safely expect to ship annually 100,000 tons of coal, 25,000 tons of coke, 75,000 tons of iron ore, and 10,000 tons of iron product. The last item would include a fair proportion of the articles manufactured by the Hoe and Tool Works, the Gibson Agricultural Works, the Duthie Machine and Foundry Company, and the Lookout Rolling Mills; and the same entry to outside markets would be afforded our furniture factory, our ice company, and all our other manufacturing interests.

In the above I have attempted to set forth in a general way the benefits of the proposed improvements that may be expected by the citizens of Harriman. It is proper to say in this connection that the town of Kingston has a merchandise business of at least $125,000 annually, and as Harriman is now the nearest railway station to that town, this business would naturally go to Kingston by water from here, and it would so go to-day could water connection be relied upon for most, if not all, of the year. Upon a fair estimate the business of Kingston above referred to would amount to at least 1,250,000 pounds of freight each year.

All of which is respectfully submitted.

James Hayward,
*Assistant Manager.*

W. H. Russell, Esq.,
*General Manager.*

# APPENDIX E E.

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## IMPROVEMENT OF TENNESSEE RIVER BETWEEN CHATTANOOGA, TENN., AND FOOT OF BEE TREE SHOALS, ALABAMA.

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### *REPORT OF CAPT. GEO. W. GOETHALS, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1893.*

IMPROVEMENTS.

1. Tennessee River between Chattanooga, Tenn., and foot of Bee Tree Shoals, Alabama.
2. Operating and care of Muscle Shoals Canal, Tennessee River.

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ENGINEER OFFICE, U. S. ARMY,
*Florence, Ala., July 6, 1893.*

GENERAL: I have the honor to transmit herewith annual reports for the works of improvement in my charge for the fiscal year ending June 30, 1893.

* * * * * * *

Very respectfully, your obedient servant,

GEO. W. GOETHALS,
*Captain, Corps of Engineers.*

Brig. Gen. THOMAS L. CASEY,
*Chief of Engineers, U. S. A.*

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## E E 1.

## IMPROVEMENT OF TENNESSEE RIVER BETWEEN CHATTANOOGA, TENN., AND FOOT OF BEE TREE SHOALS, ALABAMA (260 MILES).

The river and harbor act of July 13, 1892, contained the following item:

> Improving Tennessee River, below Chattanooga, Tennessee: Continuing improvement, five hundred thousand dollars, of which twenty-five thousand dollars may be used in continuing the work at Livingston Point, Kentucky.

Of the amount appropriated as above the sum of $475,000 was allotted to the portion of the river between Chattanooga, Tenn., and the foot of Bee Tree Shoals, Alabama. This allotment was divided as follows:

| | |
|---|---|
| 1. From Chattanooga, Tenn., to Decatur, Ala. (180 miles) | $75,000 |
| 2. From Decatur, Ala., to Florence, Ala. (50 miles) | 100,000 |
| 3. From Florence, Ala., to the foot of Bee Tree Shoals (30 miles) | 300,000 |

### 1. CHATTANOOGA, TENN., TO DECATUR, ALA.

The serious obstructions to continuous navigation through this section of the river, are Ross Towhead, Burris Bar, "The Suck," the reefs near Bridgeport, Ala., Widow Bar, Guntersville Bar, and Beards Reef.

*Ross Towhead.*—This divides the river about 1 mile below Chattanooga into two portions; the right chute, generally used during the medium and higher-water stages, is not navigable during low water, because of rock ledges extending across to the towhead. The left chute was selected for navigation and, to increase the depth of water, two riprap dams were built in 1873-'74; one extends from the head about two-thirds across to the right bank; the other, from the foot of the towhead, downstream for a distance of 400 feet. Gravel washed out from above has accumulated at the foot of the longitudinal dam until at present a gravel bar connects its extremity with the left bank; about 18 inches is the available depth at extreme low water.

*Burris Bar.*—Williams Island, about 7 miles below Chattanooga, divides the river, the present low-water channel being to the right of the island. This channel is obstructed by Burris Bar, consisting of ledges of rock, entirely across the channel; the bar is about 1,800 feet in length and the available depth, at extreme low-water mark, is about 1 foot. The left channel is obstructed by a short reef at the head, and by snags and bowlders. No work of improvement has been done here.

*The Suck.*—"The Suck" is the name commonly applied to the several rapids and sheals where the river winds in a tortuous route through the mountains below Chattanooga, covering a distance of 8.5 miles, in which the fall is 16.5 feet. The obstructions, separated by pools, are known as Tumbling Shoals, The Suck, The Pot, The Skillet, and The Pan, and are formed by rock reefs and bowlders, and by projecting rocky points from both shores, which contract the waterway. At low-water stages Tumbling Shoals and The Skillet are especially difficult to navigate; as the river rises, The Suck, including Suck Point, becomes difficult to stem, while The Pot and The Pan are very great obstructions during the high stages.

The channel work carried on in 1869 and 1870 at The Suck and The Pot, and in 1889 at The Pan, consisted in widening the cross section by the removal of bowlders, projecting rocky points, and overhanging trees, and has resulted in somewhat diminishing the velocity of the current, but upstream navigation is still attended with delays caused by the necessity of laying lines and warping vessels over the swiftest places.

*Bridgeport Reefs.*—The river near Bridgeport, Ala., is divided into two portions by an island about 5 miles long, the left-hand chute being the steamboat channel. The obstructions here consist of a gravel deposit near the head of the island, and limestone reefs above the railroad bridge and near the foot of the island. At extreme low water the available depth is about 18 inches; the fall is about one foot to the mile.

*Widow Bar.*—This obstruction, another rock reef, is about 2¼ miles below Bridgeport Island, and is about 2,800 feet in length, the depth of water varying from 1.5 to 2.5 feet.

*Guntersville Bar.*—The river just above Guntersville is obstructed by bowlders and loose detached rock, making the steamboat channel very tortuous, and difficult of passage during low-water stages. The navigation of this part of the river is further impeded by a rock ledge 300 feet long, on which there is a minimum depth of 1 foot of water.

*Beards Reef.*—This obstruction is about 3 miles below Guntersville

Landing, and consists of a rock ledge crossing the river normal to its banks, with a gap near the right bank which is used as a steamboat channel, but which is obstructed by detached rocks.

Other obstructions of minor importance are said to exist between Guntersville and Decatur, but their exact nature and extent are not known, as a survey of this portion of the river has never been made.

The approved project for this section of the river is "to remove obstructions so as to secure a depth of at least 3 feet at low water."

Of the allotment of $50,000 for this purpose, made from appropriation of September 19, 1890, there had been expended, at the close of the fiscal year ending June 30, 1892, the sum of $38,106.80. This money was applied, in addition to the work of removing obstructions, to making an instrumental survey of the river from Chattanooga for a distance of 32 miles, and the results of the survey were platted.

The channel at Poor Horse and Broad Axe bars, immediately below Tumbling Shoals, was straightened, large bowlders removed, and overhanging trees up to high-water mark, between Tumbling Shoals and the Suck, were cut down to facilitate the discharge during the medium and higher stages of water. All of the work was done by hired labor.

A contract was entered into December 11, 1891, with Neely & Smith, of Chattanooga, Tenn., for excavating a channel through Guntersville Reef.

The allotment of $75,000 from the appropriation of July 13, 1892, for the improvement of this section of the river was applied to channel excavation at Ross Towhead, continuing work already begun at Tumbling Shoals, and channel excavation at Bridgeport, Ala., with the following results:

In furtherance of the contemplated project of improvement at Ross Towhead, a contract was entered into with W. A. Kirk, of Madison, Ind., October 6, 1892, for excavating and dredging a channel along the right bank of the river, 150 feet wide and 1,700 feet long, and using the material thus obtained in the construction of a riprap dam to close the left-hand chute. An unexpected rise in November greatly interfered with the prosecution of the work, and the time for completing the contract was extended from February 1, 1893, to February 1, 1894. Under this contract 280 cubic yards of rock were blasted and removed and 6,743 cubic yards of gravel dredged.

The project of improvement at Tumbling Shoals contemplated the excavation of a channel 120 feet wide through obstructing reefs and the removal of bowlders, which would have the effect of reducing the fall at this locality. Work was resumed here as soon as the stage of water would permit in July, 1892, and the necessary blasting was completed in November, 1892. A temporary dam 10 to 14 feet high and 300 feet long, consisting of timber tripods joined together and sheeted with planks, was constructed for the purpose of deflecting the river current from the work in progress. The reef consisted of sandstone, 2,798 cubic yards of which were blasted and removed, resulting in the straightening of the channel and the distribution of the fall over a longer distance, the slope being reduced about seven-tenths of a foot. There is still to be removed by dredging a quantity of small stone, the result of blasting, before the present project of improvement at this point is completed. In addition to the work above specified ring-bolts were placed along the bank to facilitate laying lines, shelters were built for dynamite and other stores, trees were cut from the banks, supplies hauled to site of work, and boats and appliances repaired and kept in order.

The project of improving the channel near Bridgeport consisted in excavating and dredging, so as to give an increased depth of water.

Proposals to do this work were invited by advertisement and bids were opened September 15, 1892. The project for the expenditure of the appropriation of July 13, 1892, had been submitted prior to the enactment of the eight-hour law of August 1, 1892; the limitation of the hours of labor required under the law so increases the cost of the contemplated work at Ross Towhead, Tumbling Shoals, and Bridgeport that it cannot be accomplished with the means available. When the bids for Bridgeport were opened they were found to be greatly in excess of the estimate, and on recommendation they were rejected. The Government being in possession of the requisite plant to do the work by hired labor, this method was authorized as most economical and advantageous.

Work was accordingly begun in October; a temporary tripod dam, 512 feet long and from 7 to 12 feet high, similar to that used at Tumbling Shoals, was thrown across the channel at the head of the island to facilitate drilling and blasting; 1,274 feet of holes were drilled, about one-third of which had been fired, when an unexpected rise occurred in November causing a suspension of the work. Since that time the water has not been at a sufficiently low stage to resume drilling. In December the United States dredge *Harwood* was transferred from the Muscle Shoals Canal to Bridgeport and worked until stopped by ice and high water. This enforced stoppage offered an opportunity to construct a new hull and transfer to it the machinery of the old dredge. In June dredging was resumed and was still in progress at the close of the fiscal year. The quantity of material removed up to that date consisted of 248 cubic yards of rock, 1,544 cubic yards of gravel, and 896 cubic yards of clay. Miscellaneous work consisted in preparing temporary shelters for men, blacksmith's forge, dynamite, subsistence and other stores, and in repairing plant.

At Guntersville, under contract with Neely & Smith, operations were begun in the fall of 1892. After the removal of 715.8 tons of rock work was interrupted in November by a sudden rise in the river, and the plant had to be transferred to a place of safety. The river has not since been at a favorable stage to resume operations. The time for completing this contract was extended to November 1, 1893.

The Nashville, Chattanooga and St. Louis Railway Company, desiring to run a transfer boat from Guntersville to Hobbs Island, a distance of about 23 miles, made a request for the clearing out of the gap above referred to as existing in Beards Reef. A preliminary examination was made, upon the result of which it was recommended that the obstructing rocks in the gap be removed, the cost not to exceed $600. The recommendation being approved 20 cubic yards of rock were removed and 10 cubic yards so broken up as not to interfere with navigation. The channel through the gap is now straight, 120 feet wide and 3 feet deep at low stages.

During the year liabilities to the amount of $75,645.26 were incurred, including contract for Ross Towhead and Guntersville Reef, leaving an available balance of $11,247.94 at the end of the fiscal year.

*Abstract of proposals for removing rock and gravel from channel at Ross Towhead, Tennessee River, opened at Engineer Office, U. S. Army, Florence, Ala., September 15, 1892.*

| No. | Name and address of bidder. | Rock (7,000 cubic yards). |  | Gravel (3,500 cubic yards). |  | Removing dam (400 linear feet). |  | Total. |
|---|---|---|---|---|---|---|---|---|
|  |  | Price. | Amount. | Price. | Amount. | Price. | Amount. |  |
| 1 | W. A. Kirk, Madison, Ind | $3.75 | $26,250 | $1.00 | $3,500 | $5.00 | $2,000 | $31,750 |
| 2 | Hoag & Co., Cincinnati, Ohio | 9.00 | 63,000 | 1.00 | 3,500 | 15.00 | 6,000 | 72,500 |
| 3 | Neely & Smith, Chattanooga, Tenn | (*) | (†) | 1.00 | 3,500 | 4.00 | 1,600 | (‡) |
| 4 | H. S. Brown, Quincy, Ill | 5.00 | 35,000 | 1.00 | 3,500 | 5.50 | 2,200 | 40,700 |

* Solid, $5.50.

† Loose, $1.50.

‡ Bid does not comply with specifications, two different prices being given for rock removal. Total can not be estimated.

Amount authorized to be expended, $31,235.

*Abstract of proposals for removing rock and gravel from channel of Tennessee River near Bridgeport, Ala., opened at Engineer Office, U. S. Army, Florence, Ala., September 15, 1892.*

| No. | Name and address of bidder. | Rock (6,000 cubic yards). |  | Gravel (20.000 cubic yards). |  | Total. |
|---|---|---|---|---|---|---|
|  |  | Price. | Amount. | Price. | Amount. |  |
| 1 | W. A. Kirk. Madison, Ind | $5.00 | $30,000.00 | $1.00 | $20,000.00 | $50,000.00 |
| 2 | J. V. Hoag & Co, Cincinnati, Ohio | 9.00 | 54,000.00 | 1.00 | 20,000.00 | 74,000.00 |
| 3 | Neely & Smith, Chattanooga, Tenn | 7.00 | 42,000.00 | 1.20 | 24,000.00 | 66,000.00 |
| 4 | H. S. Brown, Quincy, Ill.* | 5.00 | 30,000.00 | 50 | 10,000.00 | 40,000.00 |

*Lowest bid.

Amount authorized to be expended, $31,000.

## 2. DECATUR, ALA. TO FLORENCE, ALA.

The principal obstructions are the Muscle Shoals, extending from deep water at Browns Ferry to deep water at Florence, a distance of 38 miles, only 8 of which are navigable, and embracing Elk River Shoals, Big Muscle and Little Muscle Shoals.

The object of the improvement is to make continuous navigation around these obstructions by means of a lateral canal.

The approved project, according to which work is being done, based upon the survey of 1872 and somewhat modified in 1877, is:

(1) To enlarge, rebuild, and straighten the old canal around Big Muscle Shoals, built by the State of Alabama in 1831–'36 and abandoned in 1837, by constructing a canal 14.5 miles long, having nine locks, with a total lift of 85 feet, and an aqueduct 900 feet long and 60 feet wide over Shoal Creek, with the necessary permanent dams and bridges over the several creeks and ravines, the canal trunk to be from 70 to 120 feet wide at the water surface and 6 feet deep, and the locks 300 feet long, 60 feet wide, with a depth of 5 feet of water on the miter sills.

(2) To construct at Elk River Shoals a canal 1.5 miles long, with two locks, having lifts of 12 feet and from 8 to 11 feet respectively, and of same dimensions as the locks at Big Muscle Shoals.

(3) To blast at Little Muscle Shoals a channel through the bed rock of the river, and to construct stone wing dams and retaining walls to contract the waterway and to check the velocity of the current at certain points; as modified in 1890, to construct a lateral canal on the

north bank 15,000 feet long, with a guard lock at the head and a lock at the foot, having a lift of 12 feet, and of the same dimensions as the locks at Big Muscle Shoals.

Up to the close of the fiscal year ending June 30, 1892, the sum of $3,067,127.43 had been expended, with the following results:

The two divisions of the canal were sufficiently completed to permit navigation at all stages of the water; channels were excavated through Browns Island Chute, Gilchrist Chute and Nance Reef; houses were built for occupancy of lock-masters and assistants; a dredge and tow-boat were constructed, and a large amount of plant purchased for use of the canal.

During the fiscal year the following work has been done:

*Elk River Division.*—The survey from Browns Ferry to Lock A, which was interrupted by high water in the fall of 1891, was completed, and the notes platted. At the Bluff Quarry, 3,449 cubic yards of earth were stripped, 8,964 cubic yards of rough stone and 10⅔ cubic yards of dimension stone were quarried. The rough stone was broken by hand into small pieces and used for tightening the longitudinal dam above Lock A, and for paving the slopes of the embankments between Locks A and B; 6,656 cubic yards of broken stone and the earth stripping were used on the dam and 5,073 cubic yards of broken stone placed on the embankments; the leakage through the dam has been considerably reduced by this means.

The towhead which had formed between Miltons Bluff and Lock A, and which impeded the free passage of boats, was removed by the dredge *Harwood*, 6,800 cubic yards of earth being thus handled.

A cistern was built at Lock A for the use of the lock-keeper by the removal of 30.3 cubic yards of earth and the construction of 14 cubic yards of brick masonry.

The material that had been laid up against the dry wall below Lock B by the dredge, was used for filling in and about the lock and behind the dry wall, 2,818 cubic yards of earth being used for this purpose.

The channel below Lock B was deepened and widened by dredging and removing 11,452 cubic yards of material, completing this part of the work to the required depth and width.

The wooden snubbing posts at locks A and B were replaced by iron ones ; four posts, each 5 feet 3 inches long and 10 inches in diameter at top, set 3 feet 7 inches into the ground and extending 1 foot 8 inches above, being placed on each side of each lock. The setting of these posts required the excavation of 51.6 cubic yards of earth and the construction of 38.8 cubic yards of masonry.

Miscellaneous work consisted in repairing vessels, tools, and appliances forming the working plant, repairing quarters, and boating material and supplies from Decatur, Ala., and other points, to the work.

*Muscle Shoals Division.*—The space behind the north wall of Lock 1 was filled, 3,160 cubic yards of earth being used for this purpose; the embankment thus formed is 20 feet wide on top back of the coping, with a rear slope of 1 on 1. The south side of the lock between the coping and the railway was graded, 250 cubic yards of earth being used for this purpose. A picket fence 200 feet long was built in front of the lock-keeper's house.

At the quarry at Lock 4, 20,153 cubic yards of stone were quarried, for use in paving the inner slope of the canal embankment ; of this amount, 9,780 cubic yards were crushed by the Gates crusher, and 6,265 cubic yards were broken by hand. The crushed and broken stone was then loaded into cars and hauled by rail to be deposited at the places on the embankment where needed; it was distributed as follows:

| Location. | Length covered. | Location. | Length covered. |
|---|---|---|---|
| Between locks— | *Lin. yards.* | Between locks— | *Lin. yards.* |
| 1 and 2 | 1,824 | 6 and 7 | 1,780 |
| 2 and 3 | 2,455 | 7 and 8 | 1,516 |
| 3 and 4 | 2,462 | 8 and 9 | 240 |
| 4 and 5 | 2,767 | | |
| 5 and 6 | 2,380 | Total length of bank covered | 15,424 |

Three cheap one-story buildings, 16 feet by 24 feet, 12 feet by 10 feet and 16 feet by 36 feet, respectively, were built as quarters and kitchens at the quarry.

A building for foreman's quarters, to replace the temporary buildings heretofore used for that purpose, was completed at Lock 6, on land belonging to the United States. It is a frame structure, 32 feet by 52 feet in plan, two stories in height, built on masonry wall and piers, with a small cellar under the kitchen. The building, which is ceiled within, has, on the first floor, an office, two dining rooms, kitchen and living rooms; on the second floor, nine sleeping rooms and a bathroom; a covered veranda extends along the entire front.

The building formerly used as a carpenter shop has been converted into quarters for white laborers, by partitioning the first floor into eight sleeping rooms and a living room. The upper floor remains unchanged and is used as a storeroom. The carpenter shop was moved into an unused building on the south side.

The plumbing in the assistant engineer's house is completed, water being supplied by means of a ram from a small stream passing through the reservation. A chimney was built on the house used for the storage of property.

A one-story frame building, 56 feet by 36 feet, with masonry wall foundation, was built on the south side of the canal, 200 yards below Lock 6, for use as a machine shop; it is ceiled on the inside and contains a pit 3 feet deep, 3½ feet wide, and 30 feet long, approached by a spur tract from the railway, which admits of access to the various parts of the locomotives in case repairs are needed. The following machines are in place: one 25-inch lathe with 18-foot bed; one 12-inch lathe with 8-foot bed; one drill press of 18-inch swing; one planer with 6-foot bed; one shearing and punching machine. Power is applied by a simple slide-valve vertical engine of 10 indicated horse power. The erection of a turbine is also in progress, which, when completed, will be principally used, thus saving the expense of fuel.

A ditch about 1,100 feet long, with a mean cross section area of 75 square feet, was excavated through the bottom land south of Lock 6 for the purpose of giving an outlet to the river for overflow from the Six Mile Wasteweir.

A picket fence 300 feet long was built around the lock-keeper's house at Lock 9.

Four iron snubbing posts of the same dimensions as those put in at the Elk River Division were placed on each side of each lock and four were placed below Lock 9. Each post is set in a 4-foot cube of masonry, composed of four stones, each about 2 by 2 by 4 feet, the top stones being held together by 1-inch round-iron clamps. A mixture of clay and gravel has been thoroughly tamped around the masonry.

A contract was entered into under date of December 14, 1892, with H. T. Morrison & Co., of Petersburg, Va., for the construction of thirty-eight balanced valves, complete, which are intended to replace the wooden slide valves now in use in the filling and emptying culverts. These valves were in course of construction, but none had been delivered at the end of the fiscal year.

The tow boat *Colbert* was constantly employed in carrying material and supplies from Decatur and Florence to both divisions of the canal. New ties were laid for a distance of 1,500 feet on Six Mile Wasteweir and for a distance of 1,400 feet on Bluewater Weir. This work was done by the section gang in addition to their regular section work.

The Government land at Locks 3 and 4 was inclosed by wire fencing.

Miscellaneous work consisted in repairs to floating plant, tools, and other appliances, and caring for the same.

During the year $104,884.21 were expended, including outstanding liabilities and the contract for valves.

*Abstract of proposals for furnishing thirty-eight iron valves for locks on the Muscle Shoals Canal, opened at Engineer Office, U. S. Army, Florence, Ala., September 30, 1892.*

| No. | Name and address of bidder. | Amount. | Remarks. |
|---|---|---|---|
| 1 | Thurman & Powell, Louisville, Ky | $16,721.93 | |
| 2 | H. T. Morrison & Co., Petersburg, Va | 11,810.20 | Lowest bid. |
| 3 | Chattanooga Car and Foundry Co., Chattanooga, Tenn | 18,049.20 | |

Amount authorized to be expended, $20,000.

### 3. FLORENCE, ALA., TO THE FOOT OF BEE TREE SHOALS.

Colbert and Bee Tree shoals, beginning about 22 miles below Florence, form the principal obstructions to navigation during the low-water stages. These shoals, which may be considered as forming one continuous obstacle, are 8 miles in length, with a total fall of 25 feet at low water, and at this stage the depth in the channel is about 1.5 feet. Four islands divide the river through the shoals longitudinally, and the work heretofore carried on for the improvement of navigation consisted in building riprap dams, which, in connection with the islands, confined the water to the chute along the north bank. Increased depth was obtained by channel excavation. This method does not give results adequate to the present needs of commerce.

The project, adopted in 1890, contemplates the construction of a lateral canal on the south bank of the river 7.8 miles long, 150 feet wide at the water surface, with a depth of 7 feet. A combined lock, with a total lift of 25 feet, was originally intended to be placed at the lower end and a guard lock at the head for use when necessary at very high water, the locks to be 80 by 350 feet, with a depth of 6 feet of water on the miter sills at extreme low water.

This project was modified after the detailed surveys of 1891 were completed by substituting for the combined lock two locks of 12 and 13 feet lift, respectively, at extreme low water, and separated by a pool 1 mile in length, and again modified in 1892 by the substitution of one lock, having a lift of 25 feet, for the two locks contemplated in the modification of 1891.

Under the project, $23,935.03 were expended up to the close of the fiscal year ending June 30, 1892, and for this sum necessary instruments were purchased, survey of location made, notes platted, the center line of proposed canal marked by stone monuments, test pits to ascertain nature of rock for foundations of lower lift lock begun, gauges read and recorded, and other necessary preliminary work continued.

During the past fiscal year the four test pits commenced in May, 1892, were completed and the rock examined to grade. The pits were about 5 feet square and were driven by the method known as cases in military mining, until water was reached; from this depth to rock frames and sheeting were used. Upon the result of these examinations was based the recommendation of December 8, 1892, subsequently approved, to substitute a single lock with a lift of 25 feet, for the two locks required by the modified project of 1891.

As soon as the United States had acquired title to the necessary land bids were invited by advertising in official newspapers for excavating the lock pit, furnishing all labor and material, and constructing the lock in accordance with the approved plans. The bids were opened on May 15 and the contract awarded to M. V. Henry, of Birmingham, Ala., on June 28, 1893. Former experience having shown the inexpediency of making improvements until the United States had clear title to the land involved, measures were early taken to secure by purchase or friendly condemnation such tracts as were necessary for the construction of the proposed canal. During the fiscal year ending June 30, 1892, satisfactory agreements had been concluded for the purchase of 269.66 acres of the 309.07 acres required for canal purposes. During the past fiscal year the purchase of all but 3.65 acres of the remaining 39.41 acres was authorized, at prices agreed upon with the owners. The examination of titles and preparation of deeds for all of the property in question has been referred to the Department of Justice. Of the 309.07 acres required title to only 82.07 acres has been vested in the United States.

In January, 1892, authority was granted to expend $3,500 in removing a number of rocks that obstructed the channel and in repairing a break at the junction of the longitudinal dam with Colbert Island. The water having sufficiently receded, work was begun in October, 1892, and completed in January, 1893, at a total cost of $1,903.53. The completion of this work necessitated the blasting and removal of 252 cubic yards of rock; 297 cubic yards of riprap were used to fill the break in the dam, 87 cubic yards of which were quarried. The towboat *Colbert* was employed to do this work.

In order to ascertain definitely the position of rock for foundation of lock walls thirty borings were made by a boring machine purchased from the Pierce Artesian Well Company. The result showed grade of rock very uniform with results obtained by the test pits. To determine, if possible, the extent of the so-called quicksand exposed while sinking the test pits, examinations were made at seventy points outside the lock site by means of drills, but the limit could not be found.

Miscellaneous work consisted in reading and recording four river gauges, platting same, preparing drawings of lock and detailed drawings of special stones.

The amount expended during the year, including outstanding liabilities, was $24,986.79. Of this amount over $15,000 was for purchase of land.

*Abstract of proposals for constructing a masonry lock at Colbert Shoals, Tennessee River, Alabama, opened at Engineer's Office, U. S. Army, Florence, Ala., Monday, May 15, 1893.*

| No. of bid. | Name and address of bidder. | Excavation (97,480 cubic yards). |  | Rock excavation (8,410 cubic yards). |  | Concrete (66 cubic yards). |  |
|---|---|---|---|---|---|---|---|
|  |  | Price. | Amount. | Price. | Amount. | Price. | Amount. |
| 1 | Kirk & Miller, Madison, Ind. | $1.20 | $116,976.00 | $1.50 | $12,615.00 | $12.00 | $792.00 |
| 2 | Petitdidier & Hoag, Cincinnati, Ohio | 1.75 | 170,590.00 | 5.00 | 42,050.00 | 9.00 | 594.00 |
| 3 | Neely & Smith, Chattanooga, Tenn | .75 | 73,110.00 | 3.00 | 25,230.00 | 8.00 | 528.00 |
| 4 | Tere A. Clark, Quincy, Ill.* | .58 | 56,538.40 | 1.00 | 8,410.00 | 5.00 | 330.00 |
| 5 | Christie & Lowe, Washington, D. C | .85 | 82,858.00 | 4.00 | 33,640.00 | 12.00 | 792.00 |
| 6 | Dunn, Lallande & Co., Birmingham, Ala. † | .48 | 46,790.40 | 1.87 | 15,726.70 | 6.75 | 445.50 |
| 7 | George T. Nelles, Leavenworth, Kans | .80 | 77,984.00 | 1.50 | 12,615.00 | 10.00 | 660.00 |
| 8 | M. V. Henry, Birmingham, Ala. | .33⅓ | 32,493.33 | 1.50 | 12,615.00 | 10.00 | 660.00 |
| 9 | Samuel Walton & Co., Roanoke, Va. | .60 | 58,488.00 | 1.25 | 10,512.50 | 7.00 | 462.00 |
| 10 | Shipman & Stewart, Washington, D. C | .70 | 68,236.00 | 2.00 | 16,820.00 | 10.00 | 660.00 |

| No. of bid. | Name and address of bidder. | Masonry. |  |  |  |  |  |  |  |
|---|---|---|---|---|---|---|---|---|---|
|  |  | Rubble (19,085 cubic yards). |  | Fine pointed (2,974 cubic yards). |  | Rough pointed (692 cubic yards). |  | Rock face (224 cubic yards). |  |
|  |  | Price. | Amount. | Price. | Amount. | Price. | Amount. | Price. | Amount. |
| 1 | Kirk & Miller, Madison, Ind | $13.00 | $248,105.00 | $19.50 | $57,993.00 | $19.25 | $13,321.00 | $19.00 | $4,256.00 |
| 2 | Petitdidier & Hoag, Cincinnati, Ohio | 13.00 | 248,105.00 | 19.00 | 56,506.00 | 17.00 | 11,764.00 | 15.00 | 3,360.00 |
| 3 | Neely & Smith, Chattanooga, Tenn | 11.50 | 219,477.50 | 17.00 | 50,558.00 | 15.00 | 10,380.00 | 13.00 | 2,912.00 |
| 4 | Tere A. Clark, Quincy, Ill.* | 8.00 | 152,680.00 | 12.00 | 35,688.00 | 9.00 | 6,228.00 | 8.50 | 1,904.00 |
| 5 | Christie & Lowe, Washington, D. C | 12.00 | 229,020.00 | 16.25 | 48,327.50 | 15.00 | 10,380.00 | 15.00 | 3,360.00 |
| 6 | Dunn, Lallande & Co., Birmingham, Ala.† | 7.88 | 150,389.80 | 16.00 | 47,584.00 | 24.00 | 9,688.00 | 11.75 | 2,632.00 |
| 7 | George T. Nelles, Leavenworth, Kans | 9.50 | 181,307.50 | 19.25 | 57,249.50 | 18.50 | 12,913.00 | 18.50 | 4,144.00 |
| 8 | M. V. Henry, Birmingham, Ala. | 9.25 | 176,536.25 | 18.00 | 53,532.00 | 13.00 | 8,996.00 | 12.00 | 2,688.00 |
| 9 | Samuel Walton & Co., Roanoke, Va | 8.00 | 152,680.00 | 22.00 | 65,428.00 | 18.00 | 12,456.00 | 15.00 | 3,360.00 |
| 10 | Shipman & Stewart, Washington, D. C | 8.00 | 152,680.00 | 20.00 | 59,480.00 | 16.00 | 11,072.00 | 16.00 | 3,584.00 |

*Abstract of proposals for constructing a masonry lock at Colbert Shoals, Tennessee River, Alabama, etc.*—Continued.

| No. of bid. | Name and address of bidder. | Sills (754 cubic yards). | | Quoins (195 cubic yards). | | Coping. | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Lock walls (998 cubic yards). | | Well walls (17 cubic yards). | |
| | | Price. | Amount. | Price. | Amount. | Price. | Amount. | Price. | Amount. |
| 1 | Kirk & Miller, Madison, Ind | $22.50 | $16,965.00 | $40.00 | $7,800.00 | $21.00 | $20,958.00 | $21.00 | $357.00 |
| 2 | Petitdidier & Hoag, Cincinnati, Ohio | 25.00 | 18,850.00 | 31.00 | 6,045.00 | 21.00 | 20,958.00 | 17.00 | 289.00 |
| 3 | Neely & Smith, Chattanooga, Tenn | 17.00 | 12,818.00 | 63.00 | 12,285.00 | 18.00 | 17,964.00 | 14.00 | 238.00 |
| 4 | Tere A. Clark, Quincy, Ill.* | 12.00 | 9,048.00 | 45.00 | 8,775.00 | 12.00 | 11,976.00 | 12.00 | 204.00 |
| 5 | Christie & Lowe, Washington, D. C | 18.00 | 13,572.00 | 60.00 | 11,700.00 | 18.50 | 18,463.00 | 18.50 | 314.50 |
| 6 | Dunn, Lallande & Co., Birmingham, Ala.† | 16.50 | 12,441.00 | 25.00 | 4,875.00 | 19.50 | 19,461.00 | 19.50 | 331.50 |
| 7 | George T. Nelles, Leavenworth, Kans | 19.50 | 14,703.00 | 50.00 | 9,750.00 | 20.00 | 19,960.00 | 20.00 | 340.00 |
| 8 | M. V. Henry, Birmingham, Ala | 22.00 | 16,588.00 | 35.00 | 6,825.00 | 20.00 | 19,960.00 | 20.00 | 340.00 |
| 9 | Samuel Walton & Co., Roanoke, Va | 24.00 | 18,096.00 | 35.00 | 6,825.00 | 24.00 | 23,952.00 | 24.00 | 408.00 |
| 10 | Shipman & Stewart, Washington, D. C | 20.00 | 15,080.00 | 60.00 | 11,700.00 | 8.00 | 7,984.00 | 8.00 | 136.00 |

| No. of bid. | Name and address of bidder. | Cut stone (173 cubic yards). | | Brick (27 cubic yards). | | Grooves (1,400 square feet). | |
|---|---|---|---|---|---|---|---|
| | | Price. | Amount. | Price. | Amount. | Price. | Amount. |
| 1 | Kirk & Miller, Madison, Ind | $18.00 | $3,114.00 | $20.00 | $540.00 | $1.00 | $1,400.00 |
| 2 | Petitdidier & Hoag, Cincinnati, Ohio | 25.00 | 4,325.00 | 19.00 | 513.00 | 1.00 | 1,400.00 |
| 3 | Neely & Smith, Chattanooga, Tenn | 17.00 | 2,941.00 | 13.00 | 351.00 | .50 | 700.00 |
| 4 | Tere A. Clark, Quincy, Ill.* | 30.00 | 5,190.00 | 12.00 | 324.00 | .50 | 700.00 |
| 5 | Christie & Lowe, Washington, D. C | 20.00 | 3.460.00 | 21.00 | 567.00 | .50 | 700.00 |
| 6 | Dunn, Lallande & Co, Birmingham, Ala.† | 17.00 | 2,941.00 | 9.50 | 256.50 | .50 | 700.00 |
| 7 | George T. Nelles, Leavenworth, Kans | 20.00 | 3,460.00 | 15.00 | 405.00 | .50 | 700.00 |
| 8 | M. V. Henry, Birmingham, Ala | 16.00 | 2.768.00 | 15.00 | 405.00 | .75 | 1,050.00 |
| 9 | Samuel Walton & Co., Roanoke, Va | 25.00 | 4,325.00 | 18.00 | 486.00 | 4.00 | 5,600.00 |
| 10 | Shipman & Stewart, Washington, D. C | 25.00 | 4,325.00 | 25.00 | 675.00 | .50 | 700.00 |

*Abstract of proposals for constructing a masonry lock at Colbert Shoals, Tennessee River, Alabama, etc.*—Continued.

| No. of bid. | Name and address of bidder. | Filling (16,932 cubic yards). | | Stone filling (1,488 cubic yards). | | Paving (367 square yards). | | Total. |
|---|---|---|---|---|---|---|---|---|
| | | Price. | Amount. | Price. | Amount. | Price. | Amount. | |
| 1 | Kirk & Miller, Madison, Ind | $0.15 | 2,539.80 | $0.75 | 1,116.00 | $1.10 | 403.70 | 509,251.50 |
| 2 | Petitdidier & Hoag, Cincinnati, Ohio | 2.00 | 33,864.00 | 2.50 | 3,720.00 | 3.00 | 1,101.00 | 624,034.00 |
| 3 | Neely & Smith, Chattanooga, Tenn | .30 | 5,079.60 | 3.50 | 5,208.00 | 1.50 | 550.50 | 440,330.60 |
| 4 | Tere A. Clark, Quincy, Ill.* | .35 | 5,926.20 | .50 | 744.00 | 3.00 | 1,101.00 | 305,766.60 |
| 5 | Christie & Lowe, Washington, D. C | .50 | 8,466.00 | 3.00 | 4,464.00 | 3.00 | 1,101.00 | 471,165.00 |
| 6 | Dunn, Lallande & Co., Birmingham, Ala† | .27 | 4,571.64 | .37 | 550.56 | 2.00 | 734.00 | 320,118.60 |
| 7 | George T. Nells, Leavenworth, Kans | .25 | 4,233.00 | 4.00 | 5,952.00 | 1.00 | 367.00 | 406,743.00 |
| 8 | M. V. Henry, Birmingham, Ala | .35 | 5,926.20 | .70 | 1,041.60 | 2.50 | 917.50 | 343,341.88 |
| 9 | Samuel Walton & Co., Roanoke, Va | .30 | 5,079.60 | .35 | 520.80 | 4.00 | 1,468.00 | 370,146.90 |
| 10 | Shipman & Stewart, Washington, D. C | .02 | 338.64 | 1.00 | 1,488.00 | 2.00 | 734.00 | 355,692.64 |

* Lowest bid. † Informal. No signature of United States officer to guarantee.

Amount available $350,000.

Appropriations for improving the Tennessee River below Chattanooga, including surveys, have been made as follows:

| | | | |
|---|---|---|---|
| March 2, 1827 | $200.00 | March 3, 1879 | $210,000.00 |
| August 30, 1852 | 50,000.00 | June 14, 1880 | 300,000.00 |
| June 9, 1860 | 1,350.00 | March 3, 1881 | 250,000.00 |
| June 12, 1860 | 1,406.94 | August 2, 1882 | 250,000.00 |
| March 3, 1871 | 80,000.00 | July 5, 1884 | 350,000.00 |
| June 10, 1872 | 50,000.00 | August 5, 1886 | 262,500.00 |
| March 3, 1873 | 100,000.00 | August 11, 1888 | 250,000.00 |
| June 23, 1874 | 100,000.00 | September 19, 1890 | 475,000.00 |
| March 3, 1875 | 360,000.00 | July 13, 1892 | 500,000.00 |
| August 14, 1876 | 255,000.00 | | |
| June 18, 1878 | 300,000.00 | Total | 4,145,456.94 |

Parts of these appropriations have been expended on improvements below Bee Tree Shoals.

The money statement for this work is consolidated with that for Tennessee River below Bee Tree Shoals (Appendix D D 2), so as to embrace the entire reach of the river below Chattanooga, as follows:

## TENNESSEE RIVER BELOW CHATTANOOGA, TENN.

### *Money statement.*

| | | |
|---|---|---|
| July 1, 1892, balance unexpended | | $153,389.61 |
| Amount appropriated by act approved July 13, 1892 | | 500,000.00 |
| | | 653,389.61 |
| June 30, 1893, amount expended during fiscal year | | 150,486.98 |
| July 1, 1893, balance unexpended | | 502,902.63 |
| July 1, 1893, outstanding liabilities | $18,394.77 | |
| July 1, 1893, amount covered by uncompleted contracts | 47,980.17 | |
| | | 66,374.94 |
| July 1, 1893, balance available | | *436,527.74 |
| Amount (estimated) required for completion of existing project | | 5,837,939.81 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895 | | 2,130,000.00 |
| Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893. | | |

---

*A contract for $305,766.60 of this amount has been awarded and is in course of execution.

COMMERCIAL STATISTICS.

| Articles. | Year ending June 30— | |
|---|---|---|
| | 1892. | 1893. |
| *Between Chattanooga, Tenn., and Decatur, Ala.* | *Tons.* | *Tons.* |
| Lumber | 3,113 | 58,525 |
| Cotton | 3,038 | 190 |
| Live stock | 621 | 197 |
| Grain | 7,396 | 1,798 |
| Flour | 1,054 | 342 |
| Cotton seed | 285 | 24 |
| General merchandise | 10,036 | 5,578 |
| Logs and wood | 45,755 | 6,090 |
| Iron | 2,250 | 4,581 |
| Staves | 5,272 | ........ |
| Total | 78,820 | 77,325 |

| Articles. | Year ending June 30— | |
|---|---|---|
| | 1892. | 1893. |
| *Between Florence, Ala., and Paducah, Ky.* | *Tons.* | *Tons.* |
| Iron | 6,970 | 14,454 |
| Staves | 3,986 | 4,141 |
| Lumber | 24,742 | 104,000 |
| Cotton | 6,105 | 1,837 |
| Peanuts | 4,649 | 2,029 |
| Live stock | 2,189 | 3,090 |
| Hoop poles | 5,690 | 124 |
| Grain | 18,249 | 12,121 |
| Flour | 6,073 | 4,352 |
| Cotton seed | 905 | 24 |
| Sand | 2,353 | 701 |
| General merchandise | 36,114 | 28,177 |
| Logs | 71,336 | 30,300 |
| Railroad ties | 46,749 | 139,203 |
| Total | 236,209 | 344,553 |

*List of steamboats (stern-wheel) plying on the Tennessee River below Chattanooga, Tenn.*

| Name of boat. | Length. | Breadth. | Depth. | Tonnage. |
|---|---|---|---|---|
| *Between Chattanooga, Tenn., and Decatur, Ala.* | *Feet.* | *Feet.* | *Feet.* | |
| Maude | ........ | ........ | 2.5 | 23.03 |
| B. F. Young | 120 | 24 | 4 | 160.68 |
| R. C. Gunter | 153 | 28 | 4 | 337.30 |
| Wyeth City | 120 | 21.5 | 4.8 | 138.96 |
| J. R. Hughes | 98 | 17 | 3.5 | 95.15 |
| Pinhook | 94 | 18 | 3 | 90.60 |
| R. T. Coles | 118 | 24.5 | 4.5 | 134.91 |
| *Below Florence, Ala.* | | | | |
| City of Savannah | 190 | 32 | 5 | 335.50 |
| City of Sheffield | 180 | 32 | 5.5 | 750 |
| City of Paducah | 183 | 37 | 5.25 | 700 |
| W. F. Nesbit | 212 | 36 | 6.5 | 680 |
| Clyde | 185 | 33 | 6 | 580 |
| A. S. Willis | ........ | ........ | ........ | 133 |
| Iron Age | 176 | 38 | 5.5 | 385.91 |
| Gus Genin | 120 | 20 | 4 | 130 |
| C. Smith | 132 | 29 | 3.5 | 350 |
| City of Chattanooga | 134 | 27.8 | 3.6 | 167.60 |
| J. P. Kindrick | 111 | 20 | 3.5 | 128.71 |
| Edwin Wood | ........ | ........ | ........ | ........ |
| J. N. Hook | 110 | 19.2 | 3 | 55.95 |
| Dick Clyde | 96 | 17.4 | 3.0 | 75.84 |
| R. A. Speed | 124 | 22 | 4.2 | 140.57 |
| Al. Martin | 112 | 23.6 | 4 | 96.68 |
| Maggie Belle | 95.6 | 18.4 | 3.6 | 52.81 |
| Rockwood | 130 | 25.6 | 4 | 150.52 |
| A. J. Duncan | 150 | 32 | 4 | 460 |

## E E 2.

## II. OPERATING AND CARE OF MUSCLE SHOALS CANAL, TENNESSEE RIVER.

The Muscle Shoals Canal, which had been in course of construction since 1875, was formally opened to public traffic on the 10th day of November, 1890.

The canal consists of two sections, known as the Elk River Division and the Muscle Shoals Division; being named thus from the shoals of the same names on the Tennessee River, around which the two sections were constructed. The Elk River Division is 1½ miles long, not less than 100 feet wide, and has two locks, known as Locks A and B, each 60 by 300 feet, with a total lift of 23 feet; the Muscle Shoals Division, beginning about 8 miles below Lock B, is 14½ miles long, from 70 to 100 feet wide, and has been constructed by rebuilding and enlarging the old canal built by the State of Alabama, 1831–1836. This canal was used for one season, but the obstructions in the river above and below, limited navigation to certain stages of the water. It was operated for a year, after which, no funds being appropriated for its maintenance, it was disused and fell into decay.

The lower division of the canal, in its present condition, contains nine locks, of the same dimensions as those in the upper division, viz: 60 feet wide and 300 feet long, with a total lift of 85 feet.

During the past fiscal year the canal was kept in working order and no delay in traffic occurred until the last month of the fiscal year. The locks, buildings and grounds were cared for and kept in good condition, the entire line of embankment was patrolled daily for the purpose of detecting leaks, a large number of which were closed with broken stone, gravel, and clay.

Work done during the year was as follows:

The dry wall on the south side of the canal just above Lock 1, having badly settled, 8 cubic yards of the old wall were removed and rebuilt.

Pavement was relaid over an area of 1,600 square yards on the Second Creek Wasteweir, extending from end to end, the stone being torn up and relaid on an 8-inch bed of broken stone and gravel; the old pavement, consisting of stones laid in earth which had been greatly washed out by overflow, was undermined and in an unsafe condition; the new pavement was laid in a bed of gravel and broken stone.

A part of the masonry of the wall of the old State canal lock which projected through the inner face of the present embankment just below Lock 2, and which interfered with the passage of vessels though the canal was removed; 41 cubic yards in quantity.

There were also removed by hand from the bed of the canal immediately below Lock 2, 105 cubic yards of stone and gravel which had been washed in from the hillside; the space here was too contracted for dredge work.

In April a heavy freshet washed out a part of the embankment behind the north wall of Lock 3, and 372 cubic yards of earth and gravel were used in repairing the damage.

The old wooden machine shop at Bluewater was torn down and the material was used in sheathing the foundations of the watchmen's houses at Locks 2, 3, 4, 5, 7, 8, and 9.

For the protection of the embankment against wash from the emptying culverts of Lock 5, a dry wall was built immediately below the lock, 100 feet long, 9 feet high, 7 feet wide at base and 3 feet wide at top; 167 cubic yards of dry rubble masonry were laid in this work; the height of the embankment above the top of the wall is 12 feet.

A projecting part of the old State canal lock wall, consisting of 21 cubic yards, and which interfered with the navigation of the canal was removed from below Lock 5.

A water tank with a capacity of 6,000 gallons was built on a masonry foundation near the shops below Lock 6, to replace the old decayed tank and to furnish water for the locomotives.

A large quantity of logs and drift which had accumulated against the aqueduct piers at Shoal Creek was removed.

A serious leak having occurred through the embankment behind the dry wall immediately above Lock 8, and the usual means having failed to close it the wall was torn down and the embankment for half its width and a length of some 50 feet removed to bed rock; the embankment and wall were then rebuilt, a vertical core of well-tamped clay, protected on either face by gravel, being carried up from bed rock to above the water line; 352 cubic yards of earth, 155 cubic yards of gravel, 32 cubic yards of broken stone, and 100 cubic yards of dry rubble masonry were used in this work which proved very satisfactory.

The following quantities of material were removed by the Bucyrus dredge:

| | Cubic yards. | | Cubic yards. |
|---|---|---|---|
| Above Lock A | 18,114 | At Bluewater dam | 2,000 |
| Between Locks A and B | 2,150 | Between Locks 5 and 6 | 6,755 |
| At head of lower division | 600 | Near Four Mile Creek | 1,400 |
| Above Lock 1 | 941 | Between Locks 6 and 7 | 84 |
| Near Second Creek | 5,500 | Below Lock 9 | 1,060 |
| Between Locks 2 and 3 | 250 | | |
| Above Lock 3 | 110 | Total | 38,964 |

There were removed from the upper division of the canal 1,332 logs and a large quantity of drift.

On the 1st day of June the most serious break yet experienced occurred through the canal embankment at a point some 200 yards above Lock 3. On the previous night a tremendous rain storm occurred, the fall being reported as 3.6 inches in nine hours. The creeks raised so high that the towpath was overflowed from Lock 2 to Lock 4. The break through the embankment extended over a length of 75 feet and down to bed rock, some 23 feet below the railway track. The damage was at once discovered and immediate measures taken to repair it. By incessant work, aided at night by use of the Wells Light the break was repaired by the 3d of the month. In this work 700 cubic yards of stone and 1,300 cubic yards of earth were used. The cost of labor and subsistence of men engaged in the repairs amounted to $1,508.51.

There were distributed along the line of railway at convenient points for use in case of breaks through embankment 1,797 cubic yards of quarried stone; 231 cubic yards were transported across the canal for use in building protecting dry walls below Locks 6 and 7.

In addition to the foregoing work, a quantity of mud was removed from near miter sills by use of hand scrapers; frequent repairs were made to keep the wicket valves in working order; a miter-gate suspension rod at Lock 2, which had been broken by the passage of a boat, was repaired; run ways on miter gates at Locks 2, 6, 8, and 9 were repaired; two wooden benches were rebuilt under drop gate at Lock 7, and broken horizontal shaft was removed, welded, and replaced, and a large amount of miscellaneous work, consisting of repairs to dredge, tools, appliances, etc., accomplished.

*Abstract of allotments.*

| | |
|---|---|
| November 28, 1890 | $40,000.00 |
| July 1, 1891 | 31,792.04 |
| July 1, 1892 | 45,232.90 |
| Total | 117,024.94 |

*Estimate of funds needed from appropriation for operating and care of canals and other works of navigation, indefinite, to be applied to current expenses in operating the Muscle Shoals Canal, from July 1, 1893, to June 30, 1894.*

| | |
|---|---|
| Amount required for fiscal year ending June 30, 1894 | $65,000.00 |
| Balance remaining from allotment of preceding year, exclusive of outstanding liabilities | 4,024.81 |
| Additional allotment required for fiscal year ending June 30, 1894 | 60,975.19 |
| To be expended as follows: | |
| 1 assistant engineer, at $200 per month | 2,400.00 |
| 1 master mechanic, at $100 per month | 1,200.00 |
| 1 overseer, at $100 per month | 1,200.00 |
| 1 clerk, at $100 per month | 1,200.00 |
| 11 lockmasters, at $75 per month, each | 9,900.00 |
| 11 assistant lockmasters, at $40 per month, each | 5,280.00 |
| 1 locomotive engineer, at $60 per month | 720.00 |
| 1 engineer at machine shop, at $60 per month | 720.00 |
| 1 telephone lineman, at $50 per month | 600.00 |
| 2 blacksmiths, at $75 per month, each | 1,800.00 |
| 1 carpenter, at $80 per month | 960.00 |
| 1 overseer, at $80 per month | 960.00 |
| 30 laborers, at $30 per month, each | 10,800.00 |
| Dredging and towboat crews, $800 per month | 9,600.00 |
| Subsistence, $525 per month | 6,300.00 |
| Repairs of dredge, plant, material, and contingencies | 11,360.00 |
| Total for year | 65,000.00 |

*Statement of traffic through the Muscle Shoals Canal during the fiscal year ending June 30, 1893, compared with the traffic for fiscal year ending June 30, 1892.*

| | Year ending June 30— | |
|---|---|---|
| | 1892. | 1893. |
| Steamers ........ number.. | 50 | 111 |
| Barges ........ do.... | 58 | [illegible] |
| Rafts ........ do.... | 11 | [illegible] |
| Miscellaneous craft ........ do.... | 13 | [illegible] |
| Tonnage ........ tons.. | 5,189 | 12,415 |
| Lumber ........ do .. | 730 | 2,[illegible] |
| Cotton ........ do... | 199 | 123 |
| Grain ........ do... | 1,585 | [illegible] |
| Flour ........ do... | (*) | [illegible] |
| Oak extract ........ do... | 1,000 | 400 |
| General merchandise ........ do... | 1,056 | 1,778 |
| Logs ........ do... | 900 | 2,[illegible] |
| Iron ........ do... | 1,130 | ........ |
| Coal ........ do... | 315 | 4 |
| Total ........ | 6,915 | [illegible] |
| Passengers ........ number.. | 1,012 | 2,[illegible] |

*Included in General Merchandise.

The above statement is exclusive of supplies brought by United States steamers.

*Detailed expenses for operating and care of Muscle Shoals Canal during the fiscal year ending June 30, 1893.*

| Month. | Office and administration. | | | Operating, care, repairs, etc. | | | |
|---|---|---|---|---|---|---|---|
| | | | | Locks A and B. | | | |
| | Salaries. | Supplies. | Total. | Labor. | Sub-sistence. | Supplies. | Total. |
| 1892. | | | | | | | |
| July | $255.00 | $6.40 | $261.40 | $340.00 | $24.00 | .......... | $364.00 |
| August | 255.00 | 2.25 | 257.25 | 335.00 | 23.35 | $21.98 | 380.33 |
| September | 255.00 | 35.75 | 290.75 | 344.35 | 40.58 | 37.32 | 422.25 |
| October | 255.00 | 1.00 | 256.00 | 328.33 | 43.40 | 21.05 | 392.78 |
| November | 255.00 | 32.42 | 287.42 | 330.83 | 47.16 | .......... | 377.99 |
| December | 255.00 | 3.46 | 258.46 | 384.17 | 49.02 | 94.15 | 527.34 |
| 1893. | | | | | | | |
| January | 255.00 | .50 | 255.50 | 653.03 | 50.63 | .......... | 703.66 |
| February | 255.00 | 10.00 | 265.00 | 795.00 | 92.29 | .......... | 887.29 |
| March | 255.00 | 7.50 | 262.50 | 795.00 | 107.21 | 8.30 | 910.51 |
| April | 255.00 | 34.90 | 289.90 | 736.00 | 100.02 | .......... | 836.02 |
| May | 255.00 | 4.25 | 259.25 | 608.33 | 103.90 | .......... | 712.23 |
| June | 255.00 | 2.50 | 257.50 | 369.67 | 47.08 | .......... | 416.75 |
| Total | 3,060.00 | 140.93 | 3,200.93 | 6,019.71 | 728.64 | 182.80 | 6,931.15 |

| Month. | Operating, care, repairs, etc. | | | | Grand total. |
|---|---|---|---|---|---|
| | Locks 1 to 9. | | | | |
| | Labor. | Subsistence. | Supplies. | Total. | |
| 1892. | | | | | |
| July | $3,134.42 | $186.71 | $206.50 | $3,527.72 | $4,158.12 |
| August | 2,632.93 | 164.40 | 300.15 | 3,097.48 | 3,735.06 |
| September | 2,667.64 | 202.32 | 41.43 | 2,911.39 | 3,624.39 |
| October | 2,603.25 | 353.54 | 103.36 | 3,060.15 | 3,708.93 |
| November | 2,663.07 | 288.67 | 306.22 | 3,257.96 | 3,923.37 |
| December | 2,639.62 | 315.48 | 19.97 | 2,975.07 | 3,760.87 |
| 1893. | | | | | |
| January | 2,415.75 | 328.52 | .............. | 2,744.27 | 3,708.43 |
| February | 2,255.00 | 269.16 | 91.57 | 2,615.73 | 3,768.02 |
| March | 2,602.50 | 278.84 | 216.87 | 3,098.21 | 4,271.22 |
| April | 2,468.48 | 350.00 | 190.96 | 3,009.44 | 4,135.36 |
| May | 3,307.27 | 405.70 | 1,408.44 | 5,121.41 | 6,092.89 |
| June | 6,590.53 | 411.14 | 1,022.61 | 8,024.28 | 8,698.53 |
| Total | 35,980.46 | 3,554.48 | 3,908.17 | 43,443.11 | 53,575.19 |

**In addition to the above, $2,400 has been authorized to be expended for repair of drop gates, and the material has been ordered.**

# APPENDIX F F.

## IMPROVEMENT OF OHIO, MONONGAHELA, CHEAT, ALLEGHENY, AND MUSKINGUM RIVERS.

### *REPORT OF LIEUT. COL. AMOS STICKNEY, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1893, WITH OTHER DOCUMENTS RELATING TO THE WORKS.*

#### IMPROVEMENTS.

1. Ohio River.
2. Operating snag boats on Ohio River.
3. Operating and care of Davis Island Dam, Ohio River, near Pittsburg, Pa.
4. Movable dam in Ohio River below mouth of Beaver River, Pennsylvania.
5. Monongahela River, West Virginia and Pennsylvania.
6. Operating and care of Locks and Dams Nos. 8 and 9, Monongahela River.
7. Purchase of Lock and Dam No. 7, Monongahela River.
8. Purchase of Lock and Dam No. 6, Monongahela River.
9. Cheat River, West Virginia.
10. Allegheny River, Pennsylvania.
11. Dam at Herr Island, Allegheny River, near Pittsburg, Pa.
12. Ice harbor at mouth of Muskingum River, Ohio.
13. Muskingum River, Ohio.
14. Operating and care of locks and dams on Muskingum River, Ohio.

#### EXAMINATIONS.

15. Ohio River at or near Elizabethtown, Ill.
16. Harbor at Evansville, Ind.
17. Ohio River between Ludlow and Covington, Ky., and Cincinnati, Ohio.
18. Little Miami River, Ohio, for ice harbor.
19. Ohio River between Ironton, Ohio, and 3 miles along and up the Ohio east of mouth of Guyan River, West Virginia.
20. Raccoon River, Ohio.
21. Location of locks and dams on Ohio River between Davis Island Dam and the dam near mouth of Beaver River, Pennsylvania.
22. Lock and dam on Allegheny River between (proposed) dam at Tarentum and Herr Island Dam, Pennsylvania.
23. Lock and dam on Allegheny River at or near Tarentum, Pa.
24. Allegheny River from Olean, N. Y., to Warren, Pa.

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UNITED STATES ENGINEER OFFICE,
*Cincinnati, Ohio, July 15, 1893.*

GENERAL: I have the honor to transmit herewith the annual reports on the works under my charge for the fiscal year ending June 30, 1893.

I was assisted by First Lieut. Harry F. Hodges, Corps of Engineers, from August 15, 1892, to April 23, 1893.

Very respectfully, your obedient servant,

AMOS STICKNEY,
*Lieut. Col. of Engineers.*

Brig. Gen. THOMAS L. CASEY,
*Chief of Engineers, U. S. A.*

## F F 1.

## IMPROVEMENT OF OHIO RIVER.

*Statement of amounts and dates of all appropriations for this work.*

| Act of Congress. | Appropriations. | Allotments. | Remarks. |
|---|---|---|---|
| Mar. 3, 1827 | $30,000.00 | | |
| Mar. 3, 1835 | 50,000.00 | | |
| July 2, 1836 | 20,000.00 | | |
| Mar. 3, 1837 | 60,000.00 | | |
| July 7, 1838 | 50,000.00 | | |
| June 11, 1844 | 100,000.00 | | |
| Mar. 3, 1847 | 6,479.25 | | |
| Aug. 30, 1852 | 90,000.00 | | |
| June 23, 1866 | | $172,000.00 | Improving Mississippi, Missouri, Arkansas, and Ohio rivers. |
| Do | | 80,000.00 | Snag boats and apparatus for improving western rivers. |
| Mar. 2, 1867 | 100,000.00 | | |
| July 25, 1868 | | 85,000.00 | Repair, preservation, extension, and completion of river and harbor works. |
| July 11, 1870 | 50,000.00 | | |
| Mar. 3, 1871 | 50,000.00 | | |
| June 10, 1872 | 200,000.00 | | |
| Mar. 3, 1873 | 200,000.00 | | |
| June 23, 1874 | 150,000.00 | | |
| Mar. 3, 1875 | 300,000.00 | | |
| Aug. 14, 1876 | 175,000.00 | | |
| June 18, 1878 | 300,000.00 | | |
| Do | 50,000.00 | | Harbor of refuge at or near Cincinnati. |
| Mar. 3, 1879 | 250,000.00 | | |
| June 14, 1880 | 250,000.00 | | |
| Mar. 3, 1881 | 350,000.00 | | |
| Mar. 21, 1882 | 100,000.00 | | Continuing work on Davis Island Dam. |
| Aug. 2, 1882 | 350,000.00 | | |
| Do | 16,000.00 | | Harbor of refuge near Cincinnati, Ohio. |
| July 5, 1884 | 600,000.00 | | |
| Do | 17,000.00 | | Do. |
| Aug. 5, 1886 | 375,000.00 | | |
| Aug. 11, 1888 | 380,000.00 | | |
| Sept. 19, 1890 | 300,000.00 | | |
| July 13, 1892 | 360,000.00 | | |
| | 5,329,479.25 | | |
| Deduct amounts transferred to other works | 125,168.48 | | |
| Total | 5,204,310.77 | 837,000.00 | |

The last appropriation for this river, $360,000, was made in the river and harbor act of July 13, 1892. The amounts specified in the act, which may be expended at special points, are as follows:

| | |
|---|---|
| For Great Miami embankment | $13,000 |
| For improving the navigation at Mound City, Ill | 30,000 |
| For dredging in Brooklyn Harbor, Ill | 10,000 |
| For completing the work at Shawneetown, Ill | 7,000 |
| Total | 60,000 |

Deducting this amount of $60,000 from $360,000 leaves $300,000 to be expended upon general improvements. This amount was allotted as follows:

| | |
|---|---|
| For work at Clusters, 52 miles below Pittsburg, to close chutes and concentrate the low-water flow, about | $42,000 |
| For work at Eight Mile Bar, 453 miles below Pittsburg, to improve the low-water channel, about | 6,500 |
| For work at Rising Sun, 502 miles below Pittsburg, to improve the low-water channel, about | 5,000 |
| For work near Scuffletown, 767 miles below Pittsburg, to improve the low-water channel, about | 28,500 |

| | |
|---|---|
| For work at French Island, 761 miles below Pittsburg, to improve the low-water channel, about | $26,000 |
| For work near Caseyville, 860 miles below Pittsburg, to improve the low-water channel, about | 32,500 |
| For work just above Mound City, 959 miles below Pittsburg, to improve the low-water channel, about | 5,500 |
| For repairs and alterations, on plans to be approved, to dams and dikes between Pittsburg and Cairo, about | 20,000 |
| For building quarters at Davis Island Dam, about | 3,500 |
| For extending guiding crib at Davis Island Dam, about | 8,000 |
| For service of United States dredging fleet, two years, about | 40,000 |
| For completion of surveys, maps, and other expenses for establishment of harbor lines at Pittsburg, Pa., Wheeling, W. Va., and Cincinnati, Ohio, about | 10,000 |
| For gauging the low-water discharge of the river at various points, about | 5,000 |
| For contingencies, engineering, office, and miscellaneous expenses, two years, about | 50,000 |
| It was deemed advisable to leave a portion of the appropriation unallotted to any special locality, in order that there might be a reserve to draw upon to supply deficiencies in estimates or to be used with possible balances remaining from allotments for undertaking additional works. For this purpose the remainder of the appropriation is available | 17,500 |
| | 300,000 |

It is proposed to have most of the construction work done by contract, but certain portions of the work can be better done by the system of hired labor, the methods to be stated in the submission of plans for each locality.

The general plan for improving the navigation of the Ohio River, now in process of execution, is to secure additional depth at islands and bars by the construction of low dams across chutes, and by building dikes, where the river is wide and shallow, so as to confine the flow to a smaller cross-section, and by dredging. A radical improvement of the upper part of the river has been commenced by the construction of a lock and movable dam at Davis Island, 5 miles below Pittsburg, and work on another lock and dam has been commenced just below Beaver, 29½ miles from Pittsburg. A snag boat and two dredges, belonging to the United States, are constantly employed when funds are available, and the stage of river permits, in taking out snags and wrecks and in dredging away gravel and rock obstructions that can not otherwise be removed.

The late day at which the appropriation of 1892 became available, prevented the accomplishment of much dike work during that season, owing to the time required for advertising, making contracts, etc., but a considerable amount of other work was done, including various surveys of bad portions of the river, operating the dredging fleet, and measuring the low-water discharge of the river at various points. The work at special points, including the Great Miami Embankment, Shawneetown Levee, dredging in Brooklyn Harbor, and improving navigation at Mound City, for which allotments were made in the act of Congress, has all been completed during the year, except that at Mound City, which is now under contract, and will be prosecuted during the coming low-water season. During the low-water period of last fall an excellent opportunity was afforded for obtaining measurements of the low-water discharge of the river at various points. A party was fitted out under the charge of Mr. J. F. Coleman, and started in a naphtha launch from Pittsburg, taking measurements below the mouths of the principal tributaries along the whole length of the river. From these measurements the volume of discharge at a very low stage has been obtained down to a point below the mouth of the Kentucky River. In the lower part of the river the obtaining of the measurements for low-water discharge was unfortunately interrupted by a few days' delay, caused by the sinking of the survey boat, during which time of delay a rise occurred. The results of this survey will be found in Mr. Coleman's report herewith, and indicate, in my opinion, that a good navigable channel with not less than 5 and probably 6 feet central depth at low water can be obtained at all but one or two points from the mouth of the river up to Marietta, a distance of 794 miles; and from Marietta up to Lock and Dam No. 6, now building, just below the mouth of Beaver River, a distance of 141½ miles, a fair navigable channel with a central depth of between 3 and 4 feet at low water, it is believed, can be obtained.

The upper part of the Ohio River in low water consists of a succession of pools and ripples. In the pools there is generally sufficient depth for navigation. On the ripples the water is shallow, with a steep surface slope, and considerable velocity of current. By means of contraction works, properly placed at these ripples, supplemented where necessary by dredging, the length of the ripple slopes may be increased. thus decreasing the declivity of the slopes, decreasing the velocity, and increasing the depth. In work of this character it is impossible to determine in advance just where and how much work will be needed, and therefore it is impossible to submit estimates for complete improvement of the channel for any given width and depth. The work must be progressive, and tentative, and owing to the varied interests and communities along nearly 1,000 miles of river, the locations of works must be at considerable distances apart, so that no one reach of river can be taken in hand and improvement completed in advance of other parts of the river. In the upper part of the river, the bed is composed of quite heavy material, mostly large gravel with a considerable quantity of loose stone. This material does not move rapidly downstream as compared with the movement of sand and other light material, and the amount of it that is brought into the river by the numerous side streams, while large in the aggregate, is not comparable to the amount that is moved by streams passing through sandy soil. But this material, on account of its resistance to the current, makes very bad obstructions, and bars formed by it are not cut out very readily as the river falls and is confined to narrower channels, as in the case of sand bars. Channels dredged through this heavy material have a considerable degree of permanence, when properly located, and this method of improvement in the upper part of the river should, in my opinion, be more vigorously prosecuted in connection with the building of works for contraction of low-water channel, and at points where the heavy material is brought into the river by side streams. There are at present occupied in this work two fine dredges belonging to the United States, which are doing excellent service, but more should be built as soon as possible, and tenders for handling the dredges with their scows should also be provided; the practice now being to hire a towboat during each season.

The material of which the bed of the river is composed gradually becomes lighter as we descend the river, and in the lower river the lack of low-water depth is due entirely to too great width of channel, especially at points where the channel crosses from one side of the river bed to the other. The volume of low-water discharge is sufficient to provide a channel, with a central depth of not less than 6 feet at low water and a width varying from 2,000 feet at the mouth to about 1,000 feet at New Albany, situated at the foot of the Falls of the Ohio. In the improvement of the various parts of the river, the practice has been to place works at those points which are most troublesome to navigation, and in thus spreading the work out on different and unconnected reaches it happens at a great many of these points the improvements have not been as thorough as desirable and some additional work will be necessary.

The great and growing commerce of this river, its numerous cities, and the rapid increase of the already large population of the valley, should appeal in strong terms for adequate appropriations for such betterment of the navigation as it is certain can be obtained by well-known methods.

On July 1, 1892, a balance of $58,186.44 remained on hand. This sum has been applied to the completion of the existing contracts, to payment of incidental expenses, and to other objects which became necessary in the course of the work, and which were not foreseen when the funds were apportioned.

At the commencement of the year the following works were unfinished: Dike at Madison, Ind., 552 miles below Pittsburg. Dike at middle of Grand Chain, 946 miles below Pittsburg. Ice Pier at Kerrs Run, Ohio, 247 miles below Pittsburg.

The following works were in progress during the year:

*Dikes at Logstown, Pa., 18½ miles below Pittsburg.*—Work was commenced at this place upon a modification of the old riprap curved training dike, so as to place it in a line perpendicular to the shore, and other spur dikes were planned to improve the low-water channel which was to be dredged. A vigorous opposition to the change was made by the Pittsburg Coal Exchange and work was stopped and a board of engineer officers convened to examine the site and report upon the plans. The board recommended the construction of the cross dike in place of the upper part of the training dike, and one other spur dike; but in view of the strong opposition of the coal-boat operators considered it advisable to omit from the plan the work that was intended for improving the low-water channel. The work done previous to the suspension of operations consisted in the removal of 150 cubic yards of stone from old dike, the placing of 497 cubic yards of stone in the new dike, and the removal by dredging of 3,790 cubic yards of gravel from the bar opposite old dike known as "Grassy Bar."

*Ice pier at Kerrs Run, 247 miles below Pittsburg.*—This ice pier is located at the upper end of the city of Pomeroy, Ohio. The contract with James R. Ware for the construction of this pier was dated May 23, 1891. Work commenced November 2, 1891, and was continued until February 16, 1892, when the stage of water prevented any further work. On recommendation of the officer in charge the time for completing this contract was extended to June 1, 1892, and again extended to September 1, 1892. The work of construction was completed August 16, 1892. Material was used in construction as follows: Stone, 6,968 cubic yards; oak timber, 100,726 feet B. M.; iron drift-bolts and mooring irons, 11,346 pounds.

*Dikes at Eight Mile Bar, 458.5 miles below Pittsburg.*—Supplementary works were constructed at this point, consisting of two spur dikes of loose stone 4 feet above low water, one 450 feet and the other 210 feet in length. These dikes were located at right angles to the current, and adjoining the timber crib dike built in 1885-'86. The material used in construction was purchased in open market and the work done by hired labor. Two thousand and forty-two and three tenths cubic yards of stone and eleven piles were used in the construction, which was completed November 14, 1892. Subsequent observations indicated an improved condition of the channel.

*Rock Bar at mouth of Licking River, 466.5 miles below Pittsburg.*—This bar consists of limestone rock in situ, covered in part by loose rock and gravel. The total area of this bar is about 48 acres, and it projects toward the Ohio shore more than half the low-water width of the river, having a narrow but comparatively deep channel on the Ohio side along the water front of the city of Cincinnati. At low water this bar completely shuts off all navigation between the Ohio and Licking Rivers. Through this bar it was proposed to cut a channel about 1,500 feet long and 200 feet wide, with a minimum depth of 4 feet at low water, and the cutting of such a channel, it was originally estimated, would involve the removal of 19,878 cubic yards of rock. The work of improvement was begun in 1887, under an allotment of $18,750 made by the river and harbor act of August 5, 1886; and under contract dated July 15, 1887, 1,384.6 cubic yards of rock were removed. This resulted in a cut being made, 65 feet wide and 135 feet long, at the south limit of the bar, and exhausted the limited sum available. By the river and harbor act of August 11, 1888, $25,000 was allotted for this work, and an additional allotment of $20,000 was made by the act of September 19, 1890. A contract was made with J. F. King, dated July 12, 1889, for the removal of rock under these allotments, but after a delay extending through two seasons the work was abandoned by the contractor and the contract annulled. Authority being granted to do the work by hired labor, material and plant were purchased and work commenced July 6, 1891. The work continued, whenever the water would permit, up to November 15, 1891, when all the work projected for the season was completed, 2,235 cubic yards of rock having been removed. The cut is now about 475 feet long through the highest part of the bar. The total quantity of rock which would have to be removed to complete the channel as originally planned would, it is now estimated, be 22,627 cubic yards. Of this there was removed in 1887 and 1891 3,619.6 cubic yards, leaving still to be excavated 19,007.4 cubic yards. The work has heretofore been accomplished by open cut in cofferdams, and has proved very costly, besides being subject to delay and interruption, sometimes for weeks together, by reason of sudden floods. The present project adopted contemplates the continuance of the excavation by submarine blasting and subsequent dredging, and a steam-drilling scow is now being constructed for use in this manner on the work. The drilling scow will be fitted with two large Ingersoll steam drills mounted on carriages, and will be provided with machinery for handling the boat and operating the spuds by steam. It is expected that the drilling scow will be able to commence operations early in the coming fiscal year.

*Removal of obstructions at Cullums Ripple, 471.5 miles below Pittsburg.*—Obstructions in the channel opposite the dike at Cullum's Ripple caused the steamboats much trouble during the low-water stage of the river in 1892. These obstructions consisted of snags, some of considerable size, railroad ties, and small drift tightly packed. A hired dredge with a small party was employed from November 15 to November 25, in removing these obstructions. Sixteen snags and 17 cords of drift were removed and suitably disposed of, leaving the channel clear.

*Great Miami Embankment, 489 miles below Pittsburg.*—The river and harbor acts of 1886 and 1889 state that the object of this work is to confine the water of the Great Miami River in great floods, "to the end that the formation of the bar in the Ohio River, now forming and obstructing navigation, may be arrested." The extension of this embankment under contract dated June 10, 1891, with John Johnson, commenced July 8, and the work provided for by the contract was fully completed by November 28, 1891; the total of material put in place was 33,435.1 cubic yards. By authority of the Chief of Engineers, dated November 17, 1891, arrangements were made with the Cleveland, Cincinnati, Chicago and St. Louis Railway Company for a further extension of this embankment to the limit of available funds. Under this arrangement 19,640 cubic yards of material was put in place by March 31, 1892, and as the available funds were exhausted the work ceased.

The river and harbor act of July 13, 1892, by special allotment provided that $13,000 be expended on further work on the embankment. A contract dated October 29, 1892, was made with Thomas T. Annis *et al.* The work under this contract was completed June 30, 1893, but the measurements by cross section have not been fully determined.

*Dredging bar at Rising Sun, Ind., 502 miles below Pittsburg.*—There are three dikes in the immediate vicinity of Rising Sun, Ind. The first projects from the Kentucky shore immediately below the crossing which makes over to the Indiana shore above the town of Rising Sun. The two remaining dikes are situated about one-half mile apart and project from the Indiana shore at Rising Sun.

A large bar lies opposite and partly below the upper dike on Indiana shore. This bar, at its highest point, extends to a level about 6 feet above low water, and the channel along the dike is narrowed to about 180 feet in width. A strong cross-current sets against the dike, this being especially dangerous at the lower or terminal end of dike, which lies in very deep water. A hired dredge was procured, which commenced work November 11, 1892, widening the channel along this dike by cutting away the side of the bar. The work was suspended by reason of high water November 30, 1892, 3,320 cubic yards having been removed and placed just below and inside the line of dike. The act of dredging induced a general scour along the edge of the bar, and a much larger amount of material was carried away in this manner than was excavated by the dredge. Observations made subsequent to the suspension of the work of dredging indicated a great improvement in the channel.

*Dike at Madison, Ind., 552 miles below Pittsburg.*—The construction of this work was ordered by Congress, and its object is to improve the harbor of Madison by deepening the water on the flat shore bar that lies along the whole front of the city. This dike was constructed under contracts dated February 9, 1889, and February 14, 1891, with William Kirk. The latter contract was extended until November 30, 1892, on account of high water. The work of construction, which had been suspended on account of high water November 22, 1891, was resumed August 1, 1892, and was completed August 31, 1892. The total length of this dike is 2,250 feet, width 30 feet, and it is carried to a height of 7 feet above low water. The amount of material used in construction of dike was as follows:

| | | |
|---|---|---|
| Piles | | 1,203 |
| Brush | cords.. | 3,363.11 |
| Riprap stone | cubic yards.. | 24,664 |
| Oak timber | feet B. M.. | 163,792 |
| Drift bolts | pounds.. | 14,921 |
| Paving (stone) | squares.. | 212 |

The total cost of this work has been $35,996.96. This dike has not produced the results intended, and further work will be necessary at this point. The business annually transacted at the wharf boat is about $240,000, and about 4,000,000 bushels of coal are handled from the river front. The shipyard and various manufacturing concerns also make use of the wharves along their respective properties.

*Embankment at Shawneetown, Ill., 848 miles below Pittsburg.*—The object of this work is stated in the river and harbor act to be "the preservation of the harbor," and the work to be done is to strengthen the existing levee by additional earth and to protect the exposed faces by riprap or paving. The balance of funds remaining from former allotments at beginning of fiscal year, together with an allotment of $7,000 made by the river and harbor act of July 13, 1892, was expended in additional strengthening and paving. No bids for this work having been received under the advertisement of September 19, 1892, arrangement was made in open market for the completion of the work. Work was commenced December 10, 1892, and completed June 1, 1893. During this time 28,028.4 cubic yards of earth and 280 cubic yards of stone were placed in the embankment.

*Brooklyn Harbor, 923 miles below Pittsburg.*—In 1884 a formation of pudding stone, or cemented gravel, known as Brooklyn Rock, which was situated directly opposite the landing at Brooklyn, Ill., and covered an area about 150 by 650 feet in extent, was broken up and removed by the United States dredges. By the river and harbor act of August 11, 1889, an allotment of $5,000, or so much thereof as might be necessary, was made for completing the removal of rock at Brooklyn Harbor. A contract for this work was made with H. S. Brown, under date of July 12, 1889, and under this contract 5,938 tons of rock were removed with a total expenditure of $6,531.80. The river and harbor act of July 13, 1892, provided that $10,000, "or so much thereof as may be necessary," should be expended in dredging in Brooklyn Harbor. The United States dredges commenced work in October, 1892, and continued work until stopped by high water, December 17, 1892. It was found necessary to dredge over most of the area covered by the work done in 1889, as the rock had not been removed to a sufficient depth; 34,050.4 cubic yards of pudding stone, 5,236 cubic yards of sand and gravel, and 10 logs and snags were removed. The funds available under the allotment for this work are now exhausted.

*Dike at middle of Grand Chain, 946 miles below Pittsburg.*—This work was constructed under contract with I. V. Hoag, jr., dated December 1, 1884, and is the middle one of three dikes built at the Grand Chain along a length of about 6 miles. The object of building these dikes at this locality is to force the channel away from the reefs of rocks which border the natural channel. As the locality is only 20 miles from the Mississippi River, flood stages in that river stop work at Grand Chain almost as effectually as floods in the Ohio. This accounts for the slow progress of the work and the long time since the contract was let. The delays which were inevitable from the nature of the location have greatly prolonged the construction of the dike and rendered seven extensions of contract necessary. Work was suspended in November, 1891, and resumed in August, 1892. The dike was completed September 23, 1892. The material used in the construction was as follows:

| | | |
|---|---|---|
| Brush | cords.. | 1,038 |
| Stone | cubic yards.. | 35,903.9 |
| Oak timber | feet, B. M.. | 951,170 |
| Drift bolts | pounds.. | 67,498 |

The excavation of 34 cubic yards of material was also required. Length of dike, 3,008 feet.

*Operations of United States dredges.*—There being no funds available for the work of dredging at the beginning of the calendar year, the dredges remained in winter quarters until after the passage of the river and harbor act of July 13, 1892. The dredges were brought to Cincinnati in the latter part of July, repairs were made, and the fleet started down the river August 16. Dredging was done at French Island, Bowlesville, and Sisters, covering the season up to about the middle of October. The dredges were then taken to Brooklyn, Ill., where work under a special allotment, and elsewhere detailed, was performed until stopped by high water in December, 1892. After the dredging fleet had started to return up the river, navigation was suspended by the ice, and temporary quarters were obtained near Alton, Ind., where it was found necessary to remain until the break-up of the ice. The fleet returned to Cincinnati in the month of February, 1893. Exclusive of the work at Brooklyn, Ill., 41,036.1 cubic yards of material were dredged. A detailed report of operations is given by Mr. E. J. Carpenter, assistant engineer in immediate charge of the United States dredges, an extract from whose report is appended.

*Gauging low-water discharge of Ohio River.*—A small party was engaged im making measurements of the low-water discharge of the Ohio River from October 6 to November 30, 1892, during which period, for the most part, an unusually low stage of water prevailed in the Ohio and its tributaries. Measurements were made at the following points:

Below Davis Island Dam.
“ the mouth of the Muskingum River.
“ “ “ “ “ Big Kanawha River.
“ “ “ “ “ Big Scioto River.
“ “ “ “ “ Kentucky River.
“ “ “ “ “ Wabash River.
“ “ “ “ “ Cumberland River.
“ “ “ “ “ Tennessee River.

The methods employed and the results obtained from the measurements are stated in an extract from the report of Mr. J. F. Coleman, assistant engineer, who conducted the operations.

*Encroachments.*—Under the river and harbor act of August 11, 1888, some of the sections of which were amended and reënacted by the river and harbor act of September 19, 1890, encroachments on the navigable waterways of the United States, or the placing of obstructions therein, were declared misdemeanors, subject to penalties on the failure to remove same when directed by the Secretary of War. The vigorous action taken during the past two years against offenders under the law has had a restraining effect, and violations of the law have been much less numerous during the past fiscal year. Information has been received at various times that certain parties were dumping material into the river or over its banks. Investigations have been made, and wherever the dumping or filling into the river interfered with navigation, or was an encroachment on the channel of the river, the matter has been reported to the United States district attorney for his action.

*Harbor lines.*—Under the provisions of section 12 of the river and harbor act of September 19, 1890, three boards of engineer officers were convened by the Chief of Engineers, under the authority of the Secretary of War, to consider and report upon the subject of harbor lines at Pittsburg, Pa., Wheeling, W. Va., and Cincinnati, Ohio. By recommendation of the boards careful surveys had been made of the three vicinities and the preparation of maps begun. This work was suspended for a time for lack of funds, but was resumed during the past fiscal year and is now well along toward completion. The maps of the vicinity of Wheeling, W. Va., having been completed, the board held a public meeting at that place April 24, 1893, and have laid out the lines which they will recommend for adoption.

*Special surveys of Ohio River.*—Special surveys were made at Clusters, 52 miles below Pittsburg; at Eight Mile Bar, 453 miles below Pittsburg; at Rising Sun, Ind., 502 miles below Pittsburg, and at Scuffletown, 767 miles below Pittsburg, to determine the exact condition of the channel at these points with a view to its improvement. These surveys were completed and maps of the vicinities prepared.

*Examinations and inspections.*—An examination was made of all the dikes and dams on the Ohio River between Pittsburg, Pa., and Cincinnati, Ohio, a distance of 466½ miles, during the low stage of the river which prevailed between October 10 and October 25, 1892. Special examinations were also made of the levee at Jeffersonville, Ind., constructed by the United States in 1885–'86, and at the solicitation of citizens of Evansville inspection of the locality opposite the city of Evansville, Ind., where it was thought a cut-off in the channel of the Ohio River was impending.

## ICE PIERS.

Ice piers are high isolated cribs filled with stone, placed at the upper end of a landing in order to ward off ice and drift. An ice pier is usually built in two or more sections, with an interval between somewhat greater than the width of a section, the lines of sections being at right angles to the shore or inclining downstream. As built on the Ohio River, ice-pier sections have a base of 24 by 44 feet and a top of 24 by 17. The outermost section is usually built to a height of 30 feet above low water and the inner sections a few feet higher.

The acts of Congress authorizing the construction of ice piers require an antecedent cession of riparian rights in favor of water craft seeking shelter from ice.

Up to the present time ice piers have been built in the Ohio River at Kerrs Run, Pomeroy, Middleport, Gallipolis, Portsmouth, Ironton, and Ripley. Their efficiency as a protection from ice and drift was thoroughly tested during the severe winter of 1892–'93, the ice gorges in the Ohio being unusually heavy and at some points very disastrous. After the break-up in January special reports were requested from the mayors of the various towns where piers had been built as to the condition of the piers, the number of craft sheltered, and the protection afforded. The following is a summary of the replies received:

*Pomeroy and Kerrs Run.*—Piers not injured; that at Pomeroy saved wharf boat. No boats harbored at Kerrs Run.

*Middleport.*—The piers proved efficient and turned the heavy ice out toward the middle of the river. The following boats were below the pier: *J. M. Clark*, *Valley Belle*, *C. A. Hill*, *Pilgrim*, *Champion No. 2*, Middleport ferryboat, steamer *Mordock*, and some barges, all of which were unharmed by the ice.

*Gallipolis.*—Piers not injured and are a great protection to boats. During break-up afforded shelter from ice to passenger boats *Hudson*, *Carrie Brown*, and *Capitol City*, two ferryboats *Champion* and *Laffi*, towboat *Cruiser* and ten barges, Gallipolis wharf boat, four barges, two fuel boats, one raft lumber, and other smaller craft.

*Portsmouth.*—Piers have afforded no protection; boats not being able to reach shelter of piers on account of shallow water.

*Ironton.*—Ice piers not damaged, so far as can be seen. Afforded protection to two steamboats, the *Georgia* and *Brooks*, and wharf boat. Piers threw ice out into the river; apparently quite satisfactory.

*Ripley.*—Piers have proven a perfect success, rendering all our boats and barges perfectly secure.

### OPERATIONS AT LOGSTOWN BAR FOR THE MONTH OF DECEMBER, 1892.

[Extract from report of Mr. William Martin.]

Work on the project for the improvement of the channel at this bar by the construction of low spur riprap stone dikes, built from each side of the river, began in November, 1892, but on account of objections made by navigators work was temporarily suspended until the 30th of the month, when a dredge was put to work removing the so-called "grassy bar," and the force constructing the dikes, which had been suspended, also resumed work. The dredge has made one cut 725 feet long, and 300 feet on a second cut, dredged to a depth of 0.3 foot above the zero of the gauge. Since the cuts have been made they have scoured by the current an average of 2.9 feet deeper. Since operations began the low-water channel lines have been changed, thus making the dredged cuts as far north of the center of channel as the lines have been changed, viz: Both lines have been relocated farther south, the north line 90 feet and the south line 60 feet. When the stage of water would admit of it, the dredged material has been deposited on a line at right angles with the current, at the root of the old dike, extending out 200 feet towards the channel.

The work of building the dikes has been confined exclusively to Dike C. On that portion between the old dike and the south shore there has been 475 feet built, lacking 30 feet to complete. On the portion north of the old dike 100 feet had been but partially built when operations were temporarily suspended. No work was done on this end of the dike when we resumed operations. There has been 150 cubic yards of riprap stone removed from the old dike and 347 cubic yards received from Hulings Brothers, of Pittsburg, making a total of 497, all of which have been used (except about 70 cubic yards) in the construction of Dike C.

### WORK OF CONSTRUCTING LOOSE STONE SPUR DIKES AT EIGHTMILE BAR DURING OCTOBER AND NOVEMBER, 1892.

[Extract from report of Mr. Edward Schenk.]

On October 7, in accordance with your instructions, I proceeded to stake out the proposed dikes, and to make a few soundings to show the condition of the river, which were platted on October 12 and 13.

The dikes were to be built to a height of 4 feet above low water, to be 5 feet wide on top, and to have the sides and end slope 1 vertical on 2 horizontal.

The core to be built to a height of 3 feet above low water, of riprap stone weighing from 50 to 100 pounds each, and to be 3 feet wide on top with side slopes of 1 on 2, this to be covered to a depth of 1 foot with large stone weighing from 200 to 400 pounds.

The upper dike was located on the Kentucky shore about 1,200 feet below the mouth of Eight mile Creek, or about 350 feet above the root of the crib dike, and extending out into the stream about 450 feet from shore at right angles to the current.

The lower dike was located about 1,300 feet below the root of the crib dike, and extends 210 feet out into the river from same, at right angles to the current.

Pile driving was begun on the upper dike on October 14.

The pile-driver floated within 50 feet of the shore, where the first pile was driven, and then two more farther out, every 40 feet.

By this time the water had fallen about 5 inches and a reef of sand had moved down across the line of the dike, making it necessary to move the pile-driver down stream around the reef and then up again to the outer end of the dike, where four more piles were driven at every 40 feet.

This left a space of about 120 feet in the middle of the dike where there are no piles, but there being only 8 inches of water on the reef they were not needed.

Two piles were driven about 150 feet above the dike to fasten barges to.

The pile-driver was now moved to the lower dike and two piles driven near the end, 50 feet apart.

Eleven piles were driven altogether with a force of 5 men in four days.

Stone began to arrive on the work on October 19, which was unloaded on the lower dike.

The barges, with but few exceptions, were loaded to draw more water than was on the bar, consequently they stuck when they came to the shoal place.

The entire force was frequently at the capstans for half a day sparring the boats off.

The river bottom at the lower dike having been riprapped, attention was paid to the end of the dike and to getting the dike in comparatively good line, which is a difficult task when the stone are thrown from a barge into 4 or 5 feet of water, as was the case here.

Many of the stone, especially the flat ones, were carried 40 or 50 feet below the line of the dike before reaching bottom.

The slope formed by unloading the stone in the swift current I found to be about 1 on 3 on the lower side of the dike, while on the upper side the slope was about 1 on 1.

About 21 cubic yards of large stone, weighing from 200 to 400 pounds, were unloaded at the end of the dike on October 24 to prevent scour, which had set in.

These stone were a sort of limestone bowlder from the Moscow quarry, and were not the best for the purpose, for they showed a tendency to roll.

The stone quarried later, from ledges from 5 to 10 inches in thickness which crop out of the river bank at Sevenmile, on the Ohio shore, are better and more rectangular in shape.

By October 27 the end of the dike had settled out of sight and the sand had cut out to a depth of 9 feet. Therefore, about 55 cubic yards more of the large stone were unloaded on the end.

These stone weighed from 200 to 1,000 pounds each. Still the end of the dike settled 2 feet in twenty-four hours.

The bottom of the river, within a radius of 50 feet from the end of the dike, was next riprapped with small stone and the end then built up with large stone. The end settled very little after this was done.

The lower dike, being above water, caused the water on the shoal place to rise about 6 inches, which made it possible to push barges to the end of the upper dike, where the first stone were unloaded on October 24.

The small stone were all wheeled into position, on account of the sand which had piled up on the line of the dike making it impossible to float the barges along the dike.

Stone were wheeled from 100 to 500 feet.

The end of this dike was built on a well riprapped bottom of stone weighing from 100 to 1,000 pounds, and stood very well.

While the water was low and the work could be seen, the dikes were kept straight and the sides had about the proper slope, but as about two-thirds of the large stone on both dikes and about one-third of the small stone on the upper dike were put on after the water had risen over the work, the dikes could not be kept on the line.

The piling driven on both dikes were chopped off on November 16 as close to the top of the dike as possible after the stone were in place.

The force employed on the work numbered about 10 men on an average, together with six barges and a steamboat.

A danger signal was displayed on the lower dike during the time of construction, and at the close of the work a buoy was fastened to the end of the dike and arrangements made for the maintenance of a red light on same until further orders.

At the time work was begun on the dikes there was about 2.5 feet of water in the channel on the bar and the bottom was full of lumps.

The steamer *Rob Roy* and two barges of brick stuck, October 13, nearly opposite the lower dike and about 600 feet out from the crib dike.

The steamer *M. P. Wells* and one barge also stuck about 100 feet below the upper dike and about 700 feet out from the root of the crib dike.

The *Rob Roy* remained in about the same position for nearly a week, and one of the barges was aground about seven weeks, which caused quite a bar to form below.

The *M. P. Wells* in working to get loose, piled up a reef of sand directly in the remaining channel, about 200 feet below the upper dike and 500 feet out from the root of the crib dike.

The water cut a small channel 100 feet wide and 20 inches deep through this reef, running across the river toward the Kentucky shore.

The water, which could not pass through this channel, in running across the river toward the Kentucky shore into the deep hole along the crib dike, caused a reef to form, extending from a point about 200 feet below the lower dike and 250 feet out from the crib dike to about half way between the lower and upper dikes, on which there were about 7 inches of water.

The lower dike soon began to turn the current which had been running along the crib dike out into the river on the reef opposite and below the dike.

Above the lower dike the reef was cut away very little, while below it was cut away 50 or 60 feet in a few days.

The small channel at the upper dike cut out and at the same time the water was backed up by the lower dike, making 30 inches of water on the shoalest place, although the river had fallen 6 inches.

The channel was deep enough, but so crooked that even the small boats running at this time could hardly make the turns.

When the upper dike was built across the channel along the shore, and the water forced out over the bar, a new channel began to form about 200 feet out from the ends of the new dikes.

This channel cut very slowly, especially at the lower end of the reef, which was making downstream, but the current around the end of the lower dike cut away the reef to the new channel.

A small plat, sent you, of a survey made on November 7 shows the condition at that time.

The river began to rise on November 10, and by the evening of the 11th the water was running over the new dikes.

When there were about 7 inches of water running over the dikes the current at the end of the lower dike became nearly parallel to the crib dike.

The hole along the crib dike I found to be filling up and the new channel getting deeper.

The shoalest water found by the boats was 5 feet at a stage of water corresponding to 4.6 feet above low water.

### OBSTRUCTIONS REMOVED FROM CHANNEL OPPOSITE CULLOMS DIKE, NOVEMBER 21 TO 25, INCLUSIVE.

[Extract from report of Mr. H. Devereux.]

One tree, 55 feet long, 30 inches diameter, three prongs and roots; 2 cords small stuff; 1 rudder, 6 inches by 4 feet, 6 feet long; 1 tree, 50 feet, 36 inches diameter, 1 fork and roots; 1 snag, 18 inches diameter, 18 feet long, four prongs; 1 log, 18 inches diameter, 20 feet long; 1 log, 20 inches diameter, 12 feet long; 4 cords small stuff; 1 log, 36 inches diameter, 20 feet long; 1 log, 18 inches diameter, 18 feet long; 1 log, 18 inches diameter, 12 feet long; 1 log, 16 inches diameter, 20 feet long; 1 log, 24 inches diameter, 16 feet long; 6 cords small stuff, below 12 inches diameter; 1 snag, 24 inches diameter, 44 feet long, three prongs; 1 snag, 42 inches diameter, 20 feet long, three prongs and roots; 1 log, 14 inches by 20 feet long; 1 gunnel, 8 by 16 inches, 66 feet; three cords small stuff; 1 log 14 inches diameter, 16 feet long; 2 cords logs, ties, and drift.

The snags were sawed so as to be no longer dangerous, all prongs, branches, and roots being removed; all material was deposited along root of dike.

### OPERATIONS DURING THE FISCAL YEAR. IMPROVEMENT OF CHANNEL AT RISING SUN, IND.

[Extract from report of Mr. R. R Jones.]

On November 8 a dredging plant was taken down the river from Cincinnati to Rising Sun. The outfit consisted of one towboat, one coal excavator, 2-30 by 160 feet barges, and two fuel boats. The stage of water in the Ohio River, when the start was made, was very low (about 3.5 feet), and when Medoc Bar was reached the tow grounded and was delayed for thirty-seven hours. Rising Sun was reached at noon November 10, and preparations were at once begun for dredging. The bar opposite the upper dike was then considerably out of water, and a number of anchorages were made by planting heavy logs in the bar, and to these logs lines were attached for the purpose of holding the dredge in position while at work. It must here be explained that the dredge (coal excavator) was not provided with spuds, so that of necessity recourse was had to lines alone. A rise in the river occurred November 11, and the bar became submerged so rapidly that all of the logs save one pulled out. Ordinary anchors were tried, but they were absolutely of no use, as the material was so hard that the flukes of anchors would not penetrate, and they simply pulled along the bottom as soon as a strain was put on the holding lines. In this emergency a long line (2,000 feet) was procured, and one end being secured to the Kentucky shore—just below the old riprap dike—the other end was carried diagonally across and down the river to the point where the dredge was working. The set of the current was across the bar—towards the dike—and as the river continued to rise, the dredge was forced away from the bar. By driving large iron pins into the submerged gravel bar, fastenings were secured for side lines and the dredge held in the desired position. After the water passed a 9-foot stage the current became more directly down stream, and this, together with the sag of the long line leading from Kentucky shore forced the dredge over on the bar and away from the dike further than was desired.

A line was secured to the dike and the dredge continued to work, held in position by three lines, one of which had to be taken in whenever a boat passed through the channel. The work of dredging commenced November 11 and continued to the 29th instant, when it was suspended and the outfit returned to Cincinnati November 30. The end which it was desired to obtain by dredging was the widening of the channel, particularly at a point opposite the lower end of dike. The low-water channel at this point was only about 180 feet wide (previous to dredging), and the reaction from the bar threw the water around the lower end of dike, making the passage, even of steamers without tows, exceedingly difficult and even dangerous. During the progress of the work the steamer *Bonanza* was driven against the dike by a combination of easterly winds and the cross current just described, and entirely disabled by the breaking of the starboard wheel, and was towed back to Cincinnati for repairs.

*Material.*—The bar opposite upper dike at Rising Sun is composed mostly of coarse gravel, with a small proportion of what could properly be termed bowlders, and some sand. Perhaps 60 per cent of the whole mass consists of gravel small enough to pass through a 3-inch ring. Thirty per cent of the whole is sand and 10 per cent is stone of the size of cobbles used in ordinary street paving. A few stone were taken up which measured 12 to 18 inches in length, but these were exceptional. Some logs were found in the course of the digging—quite rotten however, and deep down in the bar—as if they had been one of the primary causes for the bar's formation at this point.

*Dredging.*—The dredging was begun at a point 650 feet above lower end of dike and 203.5 feet out from dike. The cut was continued downstream to a point 100 feet below the end of dike and 250 feet out from the dike. Total length of cut 750 feet and width from 20 to 70 feet. The deepest cutting was done next to the bar (sometimes through the highest part of the bar), and even where all the intervening surface between this new channel and the old one was not removed by dredging, the current cut it away rapidly.

*Quantity.*—The material dredged amounting to 3,320 cubic yards, was loaded on barges, taken to the foot of the upper dike, and thrown off just inside the line of dike. The deposition of material at this point created an artificial bar or dike—partly submerged—which materially assisted in deflecting the current and thereby resisting the tendency of the current to turn in towards the Indiana shore. This together with the widening of channel to 250 feet (at the lower end) has greatly improved navigation.

*Improved condition.*—On December 11 a tow of empty barges, thirty pieces in all, in charge of one steamer only, passed through the improved channel. The entire tow was about 140 feet wide and 700 feet long, and it was taken through without breaking up into two or more sections, as was formerly done. Some little difficulty was experienced at first on account of the tow not being headed properly, but when this was accomplished the passage was successfully made. It is believed that this could not have been accomplished under the old conditions.

*Cutting by current.*—Soundings taken before and after the work of dredging indicate that the material washed out by the current as a result of dredging far exceeded the amount actually taken up by the dredge, probably two or three times as much.

The work was carried on under some difficulties, with an impromptu dredging plant and with constantly changing conditions as to stage of river and direction of current. In view of all the conditions the work thus far accomplished is believed to be a success, and it is further believed that a continuation of the dredging, both above and below the points now improved, will effectually cure all trouble at Rising Sun so far as it is caused by the upper dike.

### WORK OF THE OHIO RIVER DREDGES DURING THE CALENDAR YEAR 1892.

[Extract from report of Mr. E. J. Carpenter.]

The dredges remained in the Kentucky River, where they had spent the winter, until after passage of the river and harbor appropriation bill, as there was no money for operating expenses nor for repairs.

Leaving Kentucky River July 20, the fleet reached Cincinnati on the 21st, and remained there until August 16, to make the repairs necessary before beginning work.

The principal and indispensable items of repairs were those required for the *Ohio's* crane arms, broken steel spud, the dipper and dipper pole; and for the *Oswego's* broken steel dipper pole, crane pillow blocks and dipper. It was necessary to recalk those seams of the scows and decked flat which had dried out above the light draft water line.

Upon completion of the repairs the dredges in tow of the *Fulton*, a towboat hired for temporary service as tender, left Cincinnati for the lower river. Owing to the low stage of water it proved necessary to hire an extra boat and to divide the fleet into two tows during the journey from Louisville to Cannelton. The first stop for work was made at French Island.

*Foot of French Island, 760.5 miles below Pittsburg.*—The improvement contemplated at this point was to make a low-water channel by removing a portion of the old riprap dike which extends from near the foot of the island. This dike, built in 1832, and repaired in 1873-'74-'75, having failed to make a low-water channel, a new dike was built from the Kentucky shore, the new plan of improvement requiring the removal of the outer and lower portion of the old dike. The dredges were employed on this work and opened a channel, which remained in good condition and was used by all boats during the ensuing low-water season, though they failed to remove as much of the old dike as was expected, because the river became so low that to get out the stone would have necessitated wasting a great deal of time in first dredging off a wide sand bar. The portions of old dike dredged out were as follows: An opening 370 feet wide was made, which extends toward French Island from a point near the shoulder where the dike turns downstream; the spur extending towards Kentucky was removed, and all of the dike immediately below it for a distance of about 1,200 feet. A pile of mixed rock and fine gravel which lay between the spur and the main dike was dredged out.

The only channel that boats could get through after about September 1 was that opened by dredging through the dike above the shoulder, which permitted them to pass between the main dike and French Island.

It seems probable that the low-water channel has been permanently improved to a considerable degree.

A number of snags were removed from the bar on the right of the channel below French Island.

Excavation made—

| | | |
|---|---|---|
| August 22 to September 10, loose rock and sand | cubic yards.. | 15,464.5 |
| September 6 to 10, five snags | tons.. | 4 |

*Bowlesville Bar, 850 miles below Pittsburg.*—While on the way from French Island to Caseyville the dredges removed from the right of the channel at this place—

| | | |
|---|---|---|
| September 12, three snags, weighing | tons.. | 17.9 |

*Caseyville Bar, 861 miles below Pittsburg.*—The object of the dredging at this place was to make a low-water channel for immediate relief to navigation, which had been stopped at this bar during the two previous low-water seasons, when there was at Caseyville about 2 feet less water than on other bars immediately above and below, resulting from the formation of a sand reef across the channel. Two cuts about 1,200 feet long and about 750 feet of a third cut were dredged through the reef, making a channel which answered all purposes during the low-water season of 1892. It is, however, altogether probable that this channel, made by cutting through soft sand, has since been filled up by the river current at the higher stages.

The river this season has not been low enough to ascertain if any trace of it now exists.

| | | |
|---|---|---|
| Excavation made September 13 to October 8, soft sand | cubic yards.. | 24,230.6 |

*The Sisters, 897 miles below Pittsburg.*—While on the way from Caseyville to Brooklyn, the dredges stopped at The Sisters to remove a short piece of old dike which lay directly in the present channel. The portion removed was the root end of the dike, a part between this and the bar below the island having been dredged out many years ago. The current having recently cut around the root of the dike, which rested on a wide sand bar, this pile of rock was left extending diagonally upstream into the narrow channel, forming a very dangerous obstruction, which had frequently been struck by boats, and which was certain to cause serious loss sooner or later. The wreck of a coal boat was found lying partly on the dike and was removed.

Material dredged out was deposited on the island shore above, where it serves to protect the bank and to deflect the water into the channel.

| | | |
|---|---|---|
| Excavation made October 10 to 12, loose rock and gravel | cubic yards.. | 1,341.0 |
| October 11, wreck removed | coal boat.. | 1 |

*Brooklyn Harbor, Illinois, 923 miles below Pittsburg.*—Dredging at this place was for the purpose of improving the harbor, as directed by the river and harbor act of July 13, 1892, which allotted $10,000 for this purpose. In 1884 the Brooklyn Rock, which was a formation of pudding stone covering an area of about 150 feet by 650 feet, and lying directly opposite the Brooklyn Landing, was broken by dynamite blasting and removed by the Ohio River dredges. In 1889 a neck of the same formation, which extended from the shore to the location of the lower end of the original rock, was dredged by contract with Mr. H. S. Brown. The improvement made in 1892 was to extend the landing at the wharf by dredging off the bar below the railroad incline.

The bar at the lower end of the wharf proved to consist of alternate layers of pudding stone and gravel, so hard that it could be removed by the dredges only with the greatest difficulty, even after blasting, because the pudding-stone strata were in many places covered by the gravel, forming a cushion that protected the rock strata from the effect of the shots. It was found necessary to dredge over almost the whole area dredged in 1889, because the material had not been removed to a sufficient depth. The work progressed with reasonable rapidity, but was very destructive to the dredge machinery, spuds, cranes, and dippers, the latter being so badly bent by it that the cost of repairing them was about half that of new dippers. Work was continued until it was stopped by high water on December 17. Cubic yards excavated, 39,286.4.

After work was stopped at Brooklyn Harbor, the dredging fleet was moved to Paducah, where the boats were put in order for the winter. On December 21 the crews were discharged and sent home, except the watchman, who remained with the boats in charge of Mr. Siewers, the engineer.

As it was impossible for the dredge tender to take the whole fleet at once to the Kentucky River, where it had been ordered to winter, the towboat was first sent up with the scows and fuel flats. Leaving Paducah on December 18, she reached Kentucky River on the 23d, and returning, started up with the dredges on the 25th. On both trips the weather was very cold and stormy, and on the 31st, after running for several days against heavy ice, the boats were laid up opposite Alton, Ind., being stopped by an ice gorge at Wolf Creek. The dredges and towboat remained at this place until January 12, 1893, when it being evident that they could not be held there when the gorge broke, they were moved across the Ohio into the mouth of Little Blue River, remaining there until February 6, when, the ice gorge having broken and passed, they were taken to the landing at Alton. On February 10, after some necessary repairs to the towboat's boilers, they again started for Kentucky River, but it having been decided to begin the annual repairs as soon as possible, an arrangement was made with the contractors for towing, to take the whole fleet to Pittsburg.

*Operations in 1893.*—The annual repairs, which began March 15, were much delayed by difficulty in getting the new boiler for the *Oswego* and materials for the crane repairs, as well as by stormy weather, which prevented work on the scows. The repairs were so far finished on June 2 as to permit the *Oswego* and one scow to begin dredging out the approach to the lower end of the Davis Island Lock. The *Ohio* and the other two scows were ready on the 5th, when they joined the *Oswego* at Davis Island, both boats working at this place until the bar was removed.

Excavation made, June 2 to 9, gravel, etc ....................cubic yards.. 3404.3

On June 9 the dredges proceeded to the foot of Deadman Island, and began removal of the bar at the mouth of Little Sewickley Creek.

This bar, which had last been dredged off in 1879, had given no trouble until within two or three years, when it again formed far enough into the channel to make it very difficult for ascending tows and packets to get past. Three cuts were made, which sufficed to remove 90 feet from the point of the creek bar and by straightening the current and destroying the eddy below the bar, materially improved this dangerous channel. More dredging should have been done, but the river being low it was thought best to move the fleet downstream, to avoid risk of being caught by low water and thus prevented from reaching other important work.

Excavation made, June 9 to 24, gravel, etc.................... cubic yards.. 16,355

There was also removed from the channel at this place two large rocks, weighing 1.75 tons.

On June 26 the dredges left Deadman Island for Mill Creek Bar, where they arrived on the 28th, having stopped to remove from the channel at Burlington Bar, June 27, one snag, weighing 6.7 tons.

At Mill Creek the dredges began removal of the bar which has built out into the channel so far as to make it difficult for boats to pass this point. Work in progress.

*Estimate for the fiscal year 1893.*

| | | |
|---|---|---|
| Ohio River dredges: | | |
| In ordinary, three months, at $475 | | $1,425 |
| Annual repairs, two months | | 3,500 |
| At work, salaries, seven months, at $1,275 | $8,925 | |
| Repairs, etc., seven months, at $150 | 1,050 | |
| | | 9,975 |
| Towboat hire, seven months, at $1,300 | 9,100 | |
| Extra towing | 400 | |
| | | 9,500 |
| Contingencies | | 600 |
| Total | | 25,000 |

**For additions to dredging plant:**

| | |
|---|---|
| 1 towboat, dredge tender | $25,000 |
| 2 fuel flats, at $1,250 | 2,500 |
| 1 decked flatboat | 2,500 |
| Total for additions to present fleet | $30,000 |

**For new dredging fleet:**

| | |
|---|---|
| 2 new dredges, complete | 65,000 |
| Outfit, tools, etc | 5,000 |
| 4 dump scows, at $4,250 | 17,000 |
| 1 towboat for dredge tender | 25,000 |
| 2 fuel flats | 2,500 |
| 1 decked flat | 2,500 |
| Total for new fleet | 117,000 |

*Ohio River dredging statement for 1892 (exclusive of work done at Brooklyn Harbor, Illinois).*

## DREDGES IN COMMISSION.

### TIME.

| Time at work. | Days. | Time lost. | Days. |
|---|---|---|---|
| Dredging sand | 18.0 | Traveling | 8 |
| Dredging loose rock and sand | 16.0 | Accidents | 1 |
| Removing snags | 0.6 | Low water | 4 |
| Removing wrecks | 0.8 | Sundays | 8 |
| | 36.0 | | 21 |

Total days in commission, 57.

### WORK.

| | | |
|---|---|---|
| Sand excavated per day of work | cubic yards | 1,346.1 |
| Sand excavated during the season | do | 24,230.6 |
| Loose rock and sand excavated per day of work | do | 1,012.4 |
| Loose rock and sand excavated during the season | do | 16,805.5 |
| Total excavation during the season | do | 41,036.1 |
| Snags removed, 8 | tons | 21.9 |
| Wreck removed, coal boat | | 1 |

### COST.

| | |
|---|---|
| **Equipment:** | |
| Per day in commission | $2.29 |
| Per day of work | 3.63 |
| For the season | 130.81 |
| **Towing and fuel:** | |
| Per day in commission | 52.67 |
| Per day of work | 83.40 |
| For the season | 3,002.25 |
| **Repairs:** | |
| Per day in commission | 2.34 |
| Per day of work | 3.70 |
| For the season | 133.33 |
| **Salaries:** | |
| Per day in commission | $43.51 |
| Per day of work | 68.89 |
| For the season | 2,479.95 |
| **Total cost:** | |
| Per day in commission | 100.81 |
| Per day of work | 159.62 |
| For the season | 5,746.34 |

### DREDGES OUT OF COMMISSION.

#### TIME.

| | Days. |
|---|---|
| In ordinary | 216 |
| Annual repairs | 26 |
| Total | 242 |

#### COST.

| | | |
|---|---|---|
| Salaries in ordinary | $2,753.97 | |
| Towing, fuel, and other expenses | 261.76 | |
| Total in ordinary | | $3,015.73 |
| Salaries during annual repairs | 1,662.56 | |
| Annual repairs (shop bills, materials, etc.) | 1,382.11 | |
| Total cost of repairs | | 3,044.67 |
| Total out of commission | | 6,060.40 |
| Cost per day in ordinary (including superintendent's pay) | | 13.96 |

#### COST OF WORK, INCLUDING ALL EXPENDITURES IN 1892.

| | |
|---|---|
| Dredging sand | $5,903.37 |
| Dredging loose rock and sand | 5,444.22 |
| Removing snags | 262.38 |
| Removing wrecks | 196.78 |
| Total expenditures in 1892 | 11,806.75 |

#### COST PER UNIT.

| | |
|---|---|
| Per cubic yard of sand excavated | $0.244 |
| Per cubic yard of loose rock and sand excavated | .334 |
| Per day in commission | 207.14 |
| Per day of work | 327.965 |

The "day of work" is for ten hours actual operations of the two dredges with three dump scows and one dredge tender.

The tow boat *John C. Fisher*, chartered as dredge tender, was paid $42.50 per day, this amount covering cost of the boat, outfit, crew, and fuel for the tow boat and dredges, except that the cost of coal in excess of 5 cents per bushel was repaid by the Government.

### *Ohio River dredges, 1892, excavation at Brooklyn Harbor, Illinois.*

#### TIME.

| At work. | Days. | Lost. | Days. |
|---|---|---|---|
| Dredging pudding stone, etc | 37.0 | Traveling | 1.0 |
| Dredging mud, gravel, etc | 4.0 | Accidents | 11.5 |
| Removing logs and snags | 0.5 | Stormy weather | 1.0 |
| | | Sundays and holidays | 12.0 |
| | 41.5 | | 25.5 |

Total, 67 days.

#### WORK.

Brooklyn Wharf at and below Ferry Landing:

| | | |
|---|---|---|
| Pudding stone, etc., excavated | cubic yards | 34,050.4 |
| Pudding stone, etc., excavated per day of work | do | 920.3 |

Brooklyn Wharf above Public Landing:

| | | |
|---|---|---|
| Mud and gravel excavated | cubic yards | 5,236.0 |
| Mud and gravel excavated per day of work | do | 1,309.0 |
| Total of excavation | do | 39,286.4 |
| Logs and snags removed, ten | tons | 17.9 |

COST.

| | | |
|---|---|---|
| For dredges (salaries, repairs, dynamite, etc.) | $3,944.87 | |
| For dredges (part annual repairs, 1893) | 1,376.49 | |
| Total for dredges | | $5,321.36 |
| For towing and fuel | | 4,678.64 |
| Total cost | | 10,000.00 |
| For excavating pudding stone, etc | | 8,915.67 |
| For excavating mud and gravel | | 963.85 |
| Removal of logs and snags | | 120.48 |
| Per day in commission | | 149.25 |
| Per day of work | | 240.96 |
| Per cubic yard pudding stone, etc., excavated | | .262 |
| Per cubic yard mud and gravel excavated | | .184 |

The "day of work" is for ten hours actual operations of the two dredges.

*Work by hired dredges in 1892, Logstown Bar, 18 miles below Pittsburg.*

| | |
|---|---|
| Excavation: | |
| November 30 to December 22, gravel and bowlders ... cubic yards.. | 3,790.0 |
| Per working day ... do.... | 216.6 |
| Cost: | |
| Hire of dredge with scows and tender, November 30 to December 22, 176¼ hours at $11 | $1,941.50 |
| For inspector and laborers | 288.07 |
| Total | 2,229.57 |
| Per cubic yard excavated | .588 |
| Per working day | 125.97 |

*Rising Sun Bar, 501.5 miles below Pittsburg.*

| | |
|---|---|
| Excavation: | |
| November 11 to 30, gravel and bowlders ... cubic yards.. | 3,320.0 |
| Per working day | 195.3 |
| Cost: | |
| Hire of dredge tender and scows, November 8 to 30, 23 days at $49 | $1,127.00 |
| Hire of dredge 20¼ days at $50 | 1,025.00 |
| For inspector and laborers | 843.76 |
| Equipment and incidental expenses | 288.62 |
| Total | 3,284.38 |
| Per cubic yard excavated | 0.99 |
| Per working day | 75.50 |

*Location and description of work.*

| Place. | From Pittsburg. | Date. | Days of work. | Kind of work. | Snags. | | No. wrecks. |
|---|---|---|---|---|---|---|---|
| | | | | | No. | Tons. | |
| | *Miles.* | 1892. | | | | | |
| Old dike, at foot of French Island. | 760.5 | Aug.-Sept.. | 14.6 | Dredging loose rock and sand. | .... | .... | .... |
| Foot of French Island ... | 761.5 | Sept ........ | 0.4 | Snagging ........ | 5 | 4.0 | .... |
| Bowlesville Bar ........ | 850.0 | Sept ........ | 0.4 | ......do ........ | 3 | 17.9 | .... |
| Caseyville Bar ........ | 861.0 | Sept.-Oct... | 18.0 | Dredging sand........ | .... | .... | .... |
| Old dike at foot of the Sisters Islands. | 897.0 | Oct ........ | 2.0 | Dredging loose rock, sand, etc. | .... | .... | .... |
| Do ........ | 897.0 | Oct ........ | 0.6 | Wrecking ........ | .... | .... | 1 |
| Total........ | ........ | ........ | 36.0 | ........ | 8 | 21.9 | 1 |

*Location and description of work*—Continued.

| Place. | Excavation. | | | | Expenditures. | | | |
|---|---|---|---|---|---|---|---|---|
| | Sand. | Loose rock and sand. | Per day of work. | Cost per cubic yard. | Removing wrecks and snags. | For dredging sand. | Dredging loose rock and sand. | Total for 1892. |
| | *Cub. yds.* | *Cub. yds.* | *Cub. yds.* | | | | | |
| Old dike, at foot of French Island. | .......... | 15,464.5 | 1,059.1 | $0.309 | ........ | ........ | $4,788.29 | $4,788.29 |
| Foot of French Island... | .......... | .......... | .......... | ........ | $131.19 | ........ | ........ | 131.19 |
| Bowlesville Bar.......... | .......... | .......... | .......... | ........ | 131.19 | ........ | ........ | 131.19 |
| Caseyville Bar.......... | 24,230.6 | .......... | 1,346.1 | .244 | ........ | $5,903.37 | ........ | 5,903.37 |
| Old dike, at foot of the Sisters Islands. | .......... | 1,341.0 | 670.5 | .489 | ........ | ........ | 655.93 | 655.93 |
| Do.............. | .......... | .......... | .......... | ........ | 196.78 | ........ | ........ | 196.78 |
| Total .............. | 24,230.6 | 16,805.5 | .......... | ........ | 459.16 | 5,903.37 | 5,444.22 | 11,806.75 |

## SERIES OF DISCHARGE OBSERVATIONS, TAKEN ON THE OHIO RIVER, FROM DAVIS ISLAND DAM TO A POINT SOME 4 MILES BELOW THE MOUTH OF THE TENNESSEE RIVER.

[Extract from the report of Mr. J. F. Coleman.]

In your letter dated October 3, 1892, which assigned this work to me, you instructed that discharge observations be taken at the following points: Below Davis Island Dam; below the mouth of the Muskingum River; below the mouth of the Big Kanawha River; below the mouth of the Big Scioto River; below the mouth of the Kentucky River; below the mouth of the Wabash River; below the mouth of the Cumberland River; and below the mouth of the Tennessee River.

Some little delay was encountered in forming a party and in securing a boat for our transportation from point to point, which would be suitable for that purpose in the low stage of water we had to contend with. Having overcome this delay the party left Pittsburg, Pa., on the morning of October 6, 1892, in a small naphtha launch with a skiff in tow and reached Davis Island Dam at 10:45 a. m. of the same day.

The party was equipped with a "Price current meter," and the necessary appliances for use with it in the measurement of velocities of the current.

The first thing necessary to be done was the "rating" of the meter. This was done by locating a "base line" (carefully measured) of 500 feet in length on the inner lock wall of the Davis Island Dam lock. At each end of this base line two or more signals were placed at right angles to it. The meter was then properly "rigged" and made ready for its work, and was lowered to a depth of 3 feet in the water over the stern of a skiff. The object was to traverse a course on the water parallel to the base line on the lock wall, the signals to indicate the exact moments the course was entered and left. The course was traveled first down, then up, noting each trip the time, in minutes and seconds, occupied in the trip and the number of revolutions made by the meter. A down and an up trip constituted a pair of trips, and the trips in each pair should be made at as nearly the same rate of speed as possible.

The pairs of trips were made at varying rates of speed, from as slow as possible to as fast as the oarsmen could force the skiff. Several pairs of trips were made.

To compute the "rating" from the field notes thus obtained, the mean velocity per second and the mean number of revolutions per second in each pair of trips is calculated, and upon a sheet of cross section paper, the vertical divisions of which represent revolutions per second and the horizontal divisions velocity per second, the result of each pair of trips is dotted. These dots are points on a compound curve, for the line of "rating" is not a straight one. In order to plat this curve through these points, a straightedge on edge and heavy paper weights are used.

The straightedge is bent to conform to all of the dots, and held in this position by the weights. The curve of "rating" is then penciled along the straightedge, through the points. From this sheet a table is compiled, showing the equivalents of revolutions per second in velocities, expressed in feet per second.

Having "rated" the meter as above, it was necessary to select a location for a cross section of the river on which to measure the discharge. As the method used in locating sections and measuring discharges is the same at all points considered in this report, it may be well to describe the manner in which it was done.

The place having been determined upon at which the section is to be located, a transit is set up on the shore of the river, and a line, the line of the section, thrown across the river, as nearly as may be at right angles to the general direction of the current. On this line two or more signals are placed on each side of the river, to indicate the section to the boatmen when taking soundings or meter observations.

Next, a base line, at right angles to the section, is measured to any convenient length, usually 1,000 feet, and at the end of this base line a point is set, to which the transit is moved, for the purpose of triangulation. The section is then thoroughly sounded, the soundings being located by triangulation.

Next, a plat of the section is made, and from this plat stations are located in sufficient number to enable the meter to arrive at the curve of velocity and in such position as to give a correct area of the sections. This done, signals are placed so as to indicate these points or stations on the section, and everything is now in readiness for the meter work to begin.

Having rigged the meter, the skiff is rowed to the first station as indicated by the above-described signals, and is anchored in accurate position. The sounding is then carefully taken and the meter lowered over the side of the skiff to one-half the depth, or, where the water is too shallow for the use of the skiff, the meter is handled by the party wading and is placed at mid-depth at the station in that way. The observation at this station is then begun and is continued for from one to five minutes, as circumstances will allow. The meter is then raised, the skiff proceeds to the next station, where the operation is repeated, and so on until an observation has been taken at each of the stations on the section.

The edges of the water at each side of the section are also located, and gauge readings are taken before and after the observation, to note the change, if any, in the stage of water.

To arrive at results from the notes thus obtained: The areas of the subdivisions of the section, as shown by the soundings, are first calculated; then the revolutions of the meter at each station are reduced to revolutions per second, and by the use of the table before mentioned are further reduced to velocities in feet per second.

The observations having been taken at mid-depth, it is necessary that 96 per cent be taken of each velocity thus obtained in order to arrive at the mean velocity at each particular station. This fact was determined in a series of observations made by Mr. W. G. Price, the inventor of this meter, also an assistant engineer under the direction, first, of Capt. Dan C. Kingman, Corps of Engineers, U. S. Army, and afterwards of First Lieut. John Millis, Corps of Engineers, U. S. Army.

Having arrived at the mean velocity of each station in this way, the average mean velocity of each subdivision is obtained, and the area of a subdivision, multiplied by the average mean velocity of that subdivision, gives the discharge in cubic feet per second for that subdivision. The discharges of the subdivisions are added, forming as a total the discharge of the section. This total discharge, divided by the total area, gives the average velocity of the entire section.

On October 7, 1892, a section was located below Davis Island Dam, and a discharge was measured, and on the 8th instant two more discharge observations were made. Leaving this section on the morning of the 10th of October, it was evening of the 14th instant before the mouth of the Muskingum River was reached. Our means of travel was slow, and then, too, the extremely low stage of water offered many obstacles to navigation. In fact, at this time navigation had come to an end for the season. An idea may be formed of the difficulties of navigation from the fact that in our trip we met no boat between Pittsburg and Augusta, Ky., and from there to the mouth of the Tennessee saw only four or five.

On October 15 a section was located below the mouth of the Muskingum River and a discharge measured. On the 17th instant another observation was obtained on this section. Leaving the mouth of the Muskingum River on the afternoon of October 17, we next stopped at Gallipolis, Ohio, some 4 miles below the mouth of the Big Kanawha River, on the evening of the 19th instant.

On the 20th instant a section was located and a discharge observation obtained, followed on the 21st by two other observations on the same section. Our next stop was below the mouth of the Big Scioto River. Here, on October 24, a section was located and a discharge measurement made. On the 25th another discharge observation was obtained, but heavy winds prevented further work at this point.

This section was left on the 26th of October, and the downstream trip was resumed. Heavy winds delayed us in reaching Cincinnati until the 28th instant. Upon arriving at Cincinnati the naphtha launch was exchanged for a small stern-wheel launch, in which the party proceeded.

On a section below the mouth of the Kentucky River two observations were taken on the 1st and one on the 2d of November. We left this point on the afternoon of the 2d instant, but did not reach the mouth of the Wabash River until the evening of the 15th instant, owing to delays caused by high winds and by the sinking of our stern-wheel launch. This occurred at midnight of November 6, and before we could raise the boat and repair her for the resumption of our journey several days had been lost. Arrived at Shawneetown, Ill., some 9 miles below the mouth of the Wabash River, on the evening of the 15th of November, we were only enabled to locate a section before the advent of several days of weather too windy to admit of meter work. Meanwhile the river began to rise, and before we were finally able, on the evening of the 19th instant, to measure a discharge, had risen 1.1 feet.

Leaving this section on November 20, the mouth of the Cumberland River was reached on the 22d instant, and the same day the section was located and a discharge observation taken.

On November 23 we arrived at the mouth of the Tennessee River, and on the 24th located a section and measured the discharge below there.

These last three sections can hardly be considered as low-water discharge observations, because of the rising river at the time of the observations.

With this report I have the honor to submit a sheet containing a plat of each of the eight sections at which discharges were measured, and a tabulated statement of results obtained. Also a table of comparative low-water stages for the years 1881. 1889, and 1892, and finally the table of "rating" for the meter used in taking the observations.

*Reduction table for use with "Price Current Meter No. 42."*

| Revolutions per second. | Velocity per second. | Revolutions per second. | Velocity per second. | Revolutions per second. | Velocity per second. | Revolutions per second. | Velocity per second. |
|---|---|---|---|---|---|---|---|
| | *Feet.* | | *Feet.* | | *Feet.* | | *Feet.* |
| 0.00 | 0.080 | 0.26 | 1.221 | 0.51 | 2.308 | 0.76 | 3.364 |
| .01 | .124 | .27 | 1.265 | .52 | 2.352 | .77 | 3.404 |
| .02 | .168 | .28 | 1.308 | .53 | 2.396 | .78 | 3.445 |
| .03 | .212 | .29 | 1.352 | .54 | 2.439 | .79 | 3.485 |
| .04 | .256 | .30 | 1.395 | .55 | 2.482 | .80 | 3.526 |
| .05 | .300 | .31 | 1.438 | .56 | 2.526 | .81 | 3.566 |
| .06 | .344 | .32 | 1.482 | .57 | 2.570 | .82 | 3.607 |
| .07 | .388 | .33 | 1.526 | .58 | 2.613 | .83 | 3.647 |
| .08 | .432 | .34 | 1.569 | .59 | 2.656 | .84 | 3.688 |
| .09 | .476 | .35 | 1.612 | .60 | 2.700 | .85 | 3.728 |
| .10 | .520 | .36 | 1.656 | .61 | 2.742 | .86 | 3.768 |
| .11 | .564 | .37 | 1.700 | .62 | 2.784 | .87 | 3.809 |
| .12 | .608 | .38 | 1.743 | .63 | 2.826 | .88 | 3.849 |
| .13 | .652 | .39 | 1.786 | .64 | 2.868 | .89 | 3.890 |
| .14 | .696 | .40 | 1.830 | .65 | 2.910 | .90 | 3.930 |
| .15 | .740 | .41 | 1.874 | .66 | 2.952 | .91 | 3.970 |
| .16 | .784 | .42 | 1.917 | .67 | 2.994 | .92 | 4.010 |
| .17 | .828 | .43 | 1.960 | .68 | 3.036 | .93 | 4.050 |
| .18 | .872 | .44 | 2.004 | .69 | 3.078 | .94 | 4.090 |
| .19 | .916 | .45 | 2.048 | .70 | 3.120 | .95 | 4.130 |
| .20 | .960 | .46 | 2.091 | .71 | 3.161 | .96 | 4.170 |
| .21 | 1.003 | .47 | 2.134 | .72 | 3.201 | .97 | 4.210 |
| .22 | 1.047 | .48 | 2.178 | .73 | 3.242 | .98 | 4.250 |
| .23 | 1.092 | .49 | 2.222 | .74 | 3.282 | .99 | 4.290 |
| .24 | 1.134 | .50 | 2.265 | .75 | 3.323 | 1.00 | 4.330 |
| .25 | 1.177 | | | | | | |

*Table showing relative low-water stages of the Ohio River for the years 1881, 1889, and 1892.*

| Point of observation below— | 1881. | | 1889. | | 1892. | |
|---|---|---|---|---|---|---|
| | Date. | Gauge reading. | Date. | Gauge reading. | Date. | Gauge reading. |
| Davis Island Dam | ........ | ........ | Sept. 3 | 1.4 | Oct. 28 | 1.6 |
| Wheeling | Sept. 23 | 0.9 | Sept. 5 | 0.8 | Oct. 24–Oct. 31 | 0.9 |
| Marietta | Sept. 10 | 1.6 | Sept. 8 | 2.2 | Nov. 2 | 2.1 |
| Point Pleasant | ........ | 0.2 | Sept. 17 | 2.0 | Oct. 26–Nov. 5 | 0.8 |
| Portsmouth | Sept. 15 | 1.3 | Sept. 11 | 4.0 | Oct. 31–Nov. 3 | 2.0 |
| Cincinnati | Sept. 18 | 1.9 | Sept. 13 | 5.2 | Nov. 5 | 2.5 |
| Madison | ........ | 1.8 | ........ | ........ | Oct. 27 | 2.8 |
| Evansville | Sept. 26 | 0.1 | Oct. 19 | 3.2 | Oct. 30, 31 | 1.3 |
| Shawneetown | Sept. 17 | 1.2 | ........ | ........ | Nov. 7–Nov. 13 | 2.2 |
| Paducah | Sept. 15 | 0.0 | Oct. 23 | 2.3 | Oct. 30–Nov. 3 | 0.7 |

*Ohio River discharge observations.*

| Date. | Point of observation below— | Distance from Pittsburg. | Gauge reading above low water. | Rising or falling. | Width of section. | Average depth. | Area of section. | Average velocity per second. | Discharge per second. | Slope per 1,000. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1892. | | *Miles.* | | | | | | *Feet.* | *Cub. ft.* | *Feet.* |
| Oct. 7 | Davis Island Dam *a*. | 4¾ | 0.70 | F. | 611 | 1.46 | 893 | 3.27 | 2,924 | 1.81 |
| Oct. 8 | Davis Island Dam *b*. | 4¾ | 0.66 | F. | 608 | 1.36 | 827 | 3.29 | 2,717 | 1.81 |
| Oct. 8 | Davis Island Dam *c*. | 4¾ | 0.60 | F. | 608 | 1.36 | 827 | 3.09 | 2,558 | 1.81 |
| Oct. 15 | Muskingum River *d*. | 172¼ | 1.10 | S. | 1,103 | 8.31 | 9,165 | 0.35 | 3,195 | ...... |
| Oct. 17 | Muskingum River *e*. | 172¼ | 1.10 | S. | 1,103 | 8.34 | 9,200 | 0.36 | 3,315 | ...... |
| Oct. 20 | Big Kanawha River *f* | 267 | 0.80 | F. | 1,006 | 5.76 | 5,797 | 0.97 | 5,652 | 0.09 |
| Oct. 21 | Big Kanawha River *g* | 267 | 0.75 | S. | 1,008 | 5.71 | 5,759 | 1.02 | 5,842 | 0.09 |
| Oct. 21 | Big Kanawha River *g* | 267 | 0.75 | S. | 1,008 | 5.63 | 5,679 | 0.96 | 5,467 | 0.09 |
| Oct. 24 | Big Scioto River *h*.. | 355¼ | 0.96 | F. | 876 | 5.50 | 4,816 | 1.41 | 6,775 | ...... |
| Oct. 25 | Big Scioto River *i* .. | 355¼ | 0.90 | S. | 867 | 5.53 | 4,806 | 1.37 | 6,606 | ...... |
| Nov. 1 | Kentucky River *j*... | 541¼ | 1.20 | S. | 1,398 | 8.93 | 12,479 | 0.55 | 6,894 | 0.15 |
| Nov. 1 | Kentucky River *k*.. | 541¼ | 1.20 | S. | 1,398 | 8.89 | 12,439 | 0.61 | 7,626 | 0.15 |
| Nov. 2 | Kentucky River *l*... | 541¼ | 1.30 | R. | 1,400 | 8.96 | 12,547 | 0.63 | 7,979 | 0.15 |
| Nov. 19 | Wabash River *m*... | 847¾ | 3.07 | R. | 1,944 | 8.09 | 16,722 | 1.29 | 20,293 | ...... |
| Nov. 22 | Cumberland River *n* | 911¼ | 4.65 | R. | 1,781 | 7.17 | 12,756 | 2.03 | 25,927 | ...... |
| Nov. 24 | Tennessee River *o*.. | 922 | 4.90 | R. | 3,702 | 11.05 | 51,906 | 1.77 | 92,104 | ...... |

*a* This section is in "Horsetail," which explains the slope. The gauge readings refer to low water of 1889. Weather fair. Strong downstream wind.

*b* Weather cloudy. Light upstream breeze.

*c* Weather cloudy. Upstream breeze; stronger than in the preceding observation.

*d* This section is 1¼ miles below the mouth of the Muskingum River. The gauge readings refer to low water of 1881. Weather cloudy. Light upstream breeze.

*e* Weather fair and calm.

*f* This section is 3¼ miles below the mouth of the Big Kanawha River. The gauge readings refer to low water of 1881. Weather cloudy and calm.

*g* Weather cloudy. Light downstream breeze.

*h* This section is 1¼ miles below the mouth of the Big Scioto River. The gauge readings refer to the low water of 1881. Weather fair. Light downstream wind.

*i* Weather cloudy. Strong wind blowing diagonally across and downstream.

*j* This section is one-quarter of a mile below the mouth of the Kentucky River. The gauge readings refer to the low water of 1881. Weather cloudy and calm.

*k* Weather cloudy. Light downstream wind.

*l* Weather cloudy. Light across-stream breeze.

*m* This section is 9 miles below the mouth of the Wabash River. The gauge readings refer to the low water of 1881. Weather clear. Light breeze across stream.

*n* This section is 3¾ miles below the mouth of the Cumberland River. The gauge readings refer to low water of 1881. Weather clear and calm.

*o* This section is 4 miles below the mouth of the Tennessee River. The gauge readings refer to low water of 1881. Weather clear. Strong downstream wind.

NOTE.—The last three observations are not to be considered as low-water observations.

## SURVEY AT CLUSTERS, OHIO RIVER.

[Extract from the report of Mr. J. Nelson Caldwell.]

The survey was made October 4 to 29, 1892.

The two islands and tow-head composing Clusters are located about 52 miles below Pittsburg, Pa.

The survey extended from the mouth of Yellow Creek, about 50¾ miles below Pittsburg, to the lower end of the bar at the mouth of Tumblesons Run, about 53¼ miles below.

The time selected for the survey was a very suitable one for such work, as the river was very low.

Starting from a point about 52 miles below Pittsburg, a base line was measured along the Ohio shore a distance of 6,600 feet downstream. This line was extended upstream 800 feet on the Ohio side and 1,600 feet on the West Virginia side. Two water gauges were put in, one at the upper end and one near the lower end of the base line. Daily readings of these gauges were made.

All soundings were reduced to low water and all elevations refer to low water at the points where cross sections were made.

Low water was taken as a mean between low water at Davis Island Dam and Wheeling. The lowest reading of the gauge at Davis Island Dam was 1.4 feet on September 3, 1889, and that of the Wheeling gauge was 0.8 feet on September 5, 1889.

From points 200 feet apart along the base line on the Ohio side of the river, lines of soundings were run across the river as nearly at right angles to the current as practicable. The soundings were made with the graduated rod by a party in the skiff, kept in line by a man on shore with a transit, and the point where each sounding was made was located by a transit man placed at stations of the base line best located for the purpose, who read and recorded the angles made by lines from the points of soundings with the base line.

Soundings were made on lines 400 feet apart along the base on the West Virginia shore.

On the portion of the work where the lines of soundings were 400 feet apart elevations were taken to the top of the bank every 800 feet; and where the lines of soundings were 200 feet apart the lines of cross-section were run across the bars and to the top of the bank of the islands and mainland every 600 feet.

Borings were made by driving a three-fourths inch steel rod to a distance of 7 feet below low water. Six lines of borings were made beginning at Station 0. The lines were 1,000 feet apart and the borings were made about 200 feet apart on the lines. The material composing the bottom was found to be coarse gravel for a depth of from 3 to 4 feet, and below that finer material, principally sand. No rock was found.

A transit line was run between and around the islands with stations on it connected with the stations of the base line by triangulation. The triangulation was extended up as far as the mouth of Yellow Creek and from the stations the outline of the low water and the high bank was located.

Several bench marks were established. Two on the Ohio shore, one near the upper end and one near the lower end of the lines of soundings, were placed on large rocks and were indicated by a square cut in the stone and marked U. S. B. M. Others were placed on projecting roots of trees and were carefully marked and witnessed.

A line of levels was run between Station 0 and Station 52 of the base line and the elevation of the water surface was taken every 200 feet. These elevations were reduced to low water and platted, and show approximately the profile of the river between these points, at low water.

### OPERATIONS DURING THE FISCAL YEAR, IMPROVEMENT OF CHANNEL AT RISING SUN, IND.

[Extract from report of Mr. H. Devereux.]

We ran a base line on the Indiana side, beginning at the root of the upper dike, and extending 8,200 feet down the river to a point 1,300 feet below the foot of the lower dike; each stake in the base line, from which soundings were taken, was centered and a right angle turned therefrom and witnessed.

The Indiana bank of the river was located by running a transit line the length of the base line, and measuring ordinates. A line parallel to the Indiana base line 2,600 feet long was laid off on the bar for convenience in observing the sounding rod and floats. From the upper end of this line, a transit line was run to the old dike on the Kentucky side, and the shore line at time of survey carefully noted; the length of the old dike is from actual measurement.

A transit line was also run from the lower end of the bar base line and ordinates to the shore line, measured as far as opposite end lower dike. The shore lines on the Indiana side were located by ordinates from the base line.

The soundings were taken with an 18-foot rod divided into feet and tenths, observed from one transit, and kept perpendicular to base line through two range poles set on base line; and at right-angle point.

Soundings were taken on lines 400 feet apart to midway the upper dike, then on lines 100 feet apart, on account of the shallow water first, and then the deep and swift water at the lower end, as it was desired to show carefully the exact width of the narrow chute.

Soundings were continued from the end of foot of the upper dike on lines 200 feet apart, except below the bar, where only every third line was carried clear across the river; below the lower dike to the end of the survey the lines were taken 400 feet apart.

The soundings were reduced to low water by subtracting 2.6, 2.4, and 2.3 feet from the daily reading of the Cincinnati gauge, 2 feet on the Cincinnati gauge being taken as low water. This agrees with local low-water marks, and shows about 2 feet of water on the bar opposite the Government light on upper dike.

Cross-sections of the Indiana bank were taken, each 1,000 feet, and show elevation above low water.

Levels were taken over the bar on lines 500 feet apart; the figures show elevation above low water.

The floats were 2 by 18 inches, 1 foot 6 inches long, poplar boards with inch square rod 6 feet long through the middle, 5 feet above with a flag on it, 1 foot extending below; this end was weighted to bring the board just below the water level. The current observations were taken every thirty seconds, two transits being used.

Six surface floats were started one at a time from the pool above the upper dike, and but one passed through the turbulent water; at the lower end of the dike one was caught in an eddy and picked up at end of dike, the other four being thrown by the cross currents into the eddy below and behind the dike.

Six more lines were started beginning at the lower end of the upper dike, and taken up below Third street, this being as far as both transits could observe the floats.

The transits were then moved and six more lines of floats observed, which carried the work the distance ordered.

The alignment of the dikes was obtained by deflections on 100-foot chords, checked by observing known points.

Levels were taken every 100 feet, and cross sections at 400-foot intervals.

The level portion of the upper dike is 6 feet above low water. It was originally constructed of stone, brush, and piles, 30 feet wide; a timber top 13 feet wide, paved, was afterwards added.

The dike is in good repair, except at lower end on river side, where the deep water has undermined it. The lower dike, built of stone, brush, and piles, 30 feet wide, is about 5¼ feet above low water. It is in good shape.

Borings were made with 1½-inch steel rod, pointed. This was driven by sledge hammers to at least 7 feet below low water, unless rock was struck, when the distance driven was carefully noted, and the elevations of the top of the hole taken with a level. The rod was drawn out by means of a lever and chain.

Borings were made on these lines 1,000 feet apart, and rock being struck, intermediate ones were taken to show the contour of the ledge.

Two bench marks were established at permanent points. Elevation 53.20 being on a large spike in First street, a well-known high-water mark. Also elevation 53.20 being the 59-foot mark on a high-water gauge built of 2 by 6 oak, painted and subdivided, nailed perpendicularly against the side of a brick building on the south side of Third or Main street, between Front and the river.

The upper pool is 1.6 feet higher than the lower, the fall of the river being 12 inches in the last 1,000 feet of the upper dike.

The lower dike does not seem to have raised the height of the pool above it, the difference between the root and foot being about 0.25 foot.

Field work began Monday, October 3, and was completed October 14, 1892.

### SURVEY OF THE OHIO RIVER AT SCUFFLETOWN, KY.

[Extract from report of Mr. C. H. Meeds.]

Scuffletown is situated on the river about 16 miles above Evansville, Ind.

Work on the survey was commenced on the 15th of September, 1892.

Lines are run on both the Indiana and Kentucky shores; and part of the soundings were taken from the Indiana side, and the remainder from the Kentucky side.

The soundings for a distance of 1¼ miles, where the crossing is from the Kentucky to the Indiana side, were made every 200 feet apart.

At the remaining stations the soundings were taken every 400 feet.

The method of taking soundings was by range poles, set usually at right angles to the base line, the angles being carefully turned by a transit; then from some station on the same line the angles were turned to the soundings as they were made.

The soundings were taken with a 13-foot sounding rod, the water being from 3.9 to 2.8 above low water, and only in one or two places did we fail to find bottom.

Borings were made for rock with a five-eighth inch steel rod to a depth of from 12 to 14 feet below low water. No solid rock was found at any place in the river; at Indiana Hill, a point just below the mouth of Cypress Creek, there is, running out into the river for a short distance, a ledge of shaly stone mixed with blue clay, which lies from 6 to 10 feet below low water.

This ledge was located by a number of borings; at one point the rod was driven 3.1 feet into the shale and clay; at another place the rod was driven through 1 foot of shale into sand or very soft material below. The ledge covers a comparatively small area, and is deep enough below low water to not interfere with navigation. At nearly all the other points where borings were taken the bottom was very soft, being largely composed of sand, and wherever gravel was found, it was very loose, the rod being easily driven from 6 to 8 inches with one blow of a light ax.

In 1832, two dams were built in the river at the crossing, one from the Kentucky shore and one from the bar on the Indiana side.

They were both, from previous reports, ordinary riprap dams; the one built out from the Kentucky shore is now entirely covered with sand and gravel.

The one built out from the bar on the Indiana side was evidently intended to be built up to the low-water stage, the end nearest the bar being a little above low water, and the downstream end is somewhat below low water.

The dam as it now stands is a detriment rather than a benefit to navigation, as it runs too far into the channel.

The opinion of an old lower river pilot was "that at least the lower part of the dam should be removed."

The dam seems to be built entirely of loose stone, and I think it could be easily removed by the dredge boats.

On the Kentucky side, there are extensive bottom lands which are overflowed during high water; most of the land is cleared and cultivated; in some places a narrow strip of timber has been left along the river bank.

The bank is composed of clay and loam, and is washed away rapidly by high water.

In places where willows have been allowed to remain, or have been set out, the bank has been greatly protected and the erosion has not been nearly so great.

The bottom is overflowed when the river reaches a stage between 40 and 45 feet above low water.

On the Indiana side, between Pigeon and Cypress Creeks, there is a stretch of very low bottom land which is overflowed at 25 to 30 feet above low water.

From Cypress Creek down the river to Newberg the banks are more or less rocky, and there is no bottom land between the river and the hills.

There is one coal mine in operation on the bank of the river near Newberg.

The survey was completed October 3, 1892; actual number of working days fifteen.

Readings were taken on a gauge which was established at the beginning of the survey, and were afterwards compared with the readings of the Evansville gauge.

## REPORT OF OPERATIONS FOR THE FISCAL YEAR.

[Extract from report of Mr. R. R. Jones.]

*Dikes and dams, Ohio River.*—In accordance with your instructions to make an examination of all the dikes and dams on Ohio River between Pittsburg and Cincinnati, I proceeded to the former city early in the month of October, 1892, and having secured a very light-draft steam launch, started down the river October 10. The stage of water at this time was exceedingly favorable for getting a good view of all the works, being at about a 2-foot stage below Davis Island Dam, so that even the older works, constructed about 1836–1840, were visible. The run was made by daylight entirely, and each work was examined as thoroughly as the time permitted. Measurements and soundings were taken and sketches of the immediate vicinity made, with notations of the apparent effect of each dike or dam upon the current and shores. Notwithstanding the very light draft of the steam launch used for the trip (15 inches), great care was required to bring it through many of the shoal places, and sparring had to be resorted to at several ripples, some of which had a depth of water of but 11 inches. At several points along the river, teams were fording from one town to another on opposite bank, and the somewhat unusual spectacle was presented of a steam vessel passing a wagon in the river. General navigation at this time was entirely suspended, except at a few points where deep pools permitted the running of very light-draft boats. Coal was scarce and even in small quantities was very difficult to obtain. Cincinnati was reached October 25, fifteen days having been consumed in making the trip of 466½ miles. The number of works examined was sixty-four, of which four had been entirely abandoned and partly removed. Some of the early constructions, 1836–1840, having been built of loosely piled stone, are now so leveled down and broken through that they have but little effect upon the current of the river. The general condition of the dikes of recent construction is good. It is desirable, however, that some small repairs be made soon. These repairs would consist of the replacement of decayed tiebeams and missing plank. A small quantity of stone would be required at some dikes for refilling. The total cost of repairs so needed would be small. The location of the dikes and dams on Ohio River examined and reported on by me are as follows:

| | Number. | Distance. |
|---|---|---|
| | | Miles. |
| Between Pittsburg, Pa., and Wheeling, W. Va | 22 | 90 |
| Between Wheeling, W. Va., and Marietta, Ohio | 17 | [illegible] |
| Between Marietta, Ohio, and Cincinnati, Ohio | 25 | [illegible] |
| | 64 | [illegible] |

*Dredging at Rising Sun Bar.*—Much complaint had been made by steamboat men of trouble experienced at Rising Sun, Ind. There are three dikes at or near this point. The first or upstream dike projects from the Kentucky shore, immediately below the crossing which makes over to the Indiana shore. The second dike is on the Indiana shore a very short distance below the first, and the third is also on the Indiana shore, one-half mile below the second. A large bar exists opposite the second dike, extending to about the middle of the lower dike. This bar is composed of gravel, small bowlders, and sand, and resists the cutting action of the river to such an extent that the channel at low water is restricted to about 180 feet opposite the second dike, but deep and with a swift current setting against the dike. Steamboats passing down are frequently driven over against the dike with more or less damage. Towboats passing up are often obliged to break up their tows and double trip through.

By your direction I procured the only available plant for dredging, and leaving Cincinnati November 8, proceeded to Rising Sun. A delay of thirty-seven hours was experienced at Medoc Bar, 20 miles below Cincinnati, by the grounding of the boats, but Rising Sun was reached November 10 and dredging commenced. The dredge was of the coal-excavator type, and being unprovided with spuds had to be secured in position by lines and anchors. Commencing at a point 650 feet above the lower end of dike, the channel was widened along and partly through the bar to a point 100 feet below the dike, the outside of the cut at lower end being 250 feet from dike. The quantity of material removed by dredging was 3,320 cubic yards, this being taken on barges to a point inside and below the dike. It was, however, estimated that from 6,000 to 10,000 cubic yards were cut away by the action of the current as a result of the dredging, so that the work done had the effect of greatly improving the channel. The dredging had to be suspended on account of high water, and the outfit returned to Cincinnati November 30.

*Levee at Jeffersonville, Ind.*—An examination was made of the levee at Jeffersonville, Ind., January 22 and 23, 1893.

The work of constructing the levee was completed under original contract in 1885, but some supplementary contracts were made which were filled in 1886.

In 1889 application was made to the Secretary of War for permission to cut through the levee at Market street for the purpose of laying a street car-track. Permission to make this cut was denied. Subsequently the city council of Jeffersonville granted permission to the street railway company to make the cut desired, and this was done. The examination of the levee, January 22 and 23, 1893, indicated that the levee was not in a condition to cause apprehension of its safety, except as regards the open cut already described. Such wear as is natural to this class of work will require repairs, such as filling out to the original outlines, where worn by rain and travel, sewing grass seed, etc. Such repairs it is estimated would cost $2,275. The open cut made by permission of the city council of Jeffersonville should be repaired, but not at the expense of the United States.

*Threatened cut-off at Evansville, Ind.*—The people of Evansville and the steamboat men have for several years been apprehensive that a cut-off would occur opposite the city, thus leaving it several miles from the new channel of the river. Evansville is located just where an abrupt bend in the Ohio River occurs. The peninsula on the Kentucky side thus formed is about 5¼ miles long, 15 miles around, and 1¾ miles across, with its outer end just opposite the city. The general surface of the peninsula is about 10 feet lower than the banks on the Indiana shore. The width of normal river channel is about 2,700 feet as shown by the survey of 1877, but during high stages of the river the entire surface of the peninsula is flooded, thus increasing the waterway by some 5¼ miles and preventing the overflow of Evansville. At several points near the neck of the peninsula deep gulleys have been cut, the general surface eroded, and the banks on upstream side have caved in. This is due to the increased fall per mile when the river flows across the peninsula and also to the fact that the trees, bushes, and vines which afford natural protection to the banks and general surface have been largely cut away in order to permit of a large area of cultivation. The soil being a sandy loam, it washes out very rapidly until a stratum of clay is reached. This clay stratum is exposed at an elevation corresponding to 21 to 22 feet on Evansville gauge.

An examination of the locality was made by me, May 22, 1893, when the stage of water was 20.60. The position of the neck on which the gulleys exist was carefully gone over and a trip by boat was made entirely around the peninsula. All the information possible was obtained from residents on the peninsula, steamboat men, and others interested in preserving the present river channel. From the best information obtainable it would appear that the cutting across the neck and the caving of the banks is now progressing more rapidly than in the past. It would also appear that very slight obstructions, such as fences and trees, suffice to arrest the eroding action in the gulleys and on the general surface. The construction of stockades or bulkheads across the gulleys and the preservation of the trees, bushes, and vines along the edge of the banks would apparently be sufficient to arrest further erosion in the gulleys and general surface, in addition to which the caving banks would have to be protected.

*Mouth of Licking River.*—A steam drilling scow is now under construction for use in the removal of rock in the mouth of Licking River by blasting and subsequent dredging.

The scow will be 125 feet in length, 22 feet in width, and of very light draft. It will be provided with spuds for holding in position and capstans for handling, both operated by steam, and will be fitted with two large Ingersoll steam drills, mounted on carriages, which will have a travel of 105 feet. It is expected to have this boat in operation during the coming month.

*Gauge at Cullums Ripple.*—Gauge readings have been made during the months of May and June, 1893, at the head of Cullums Ripple, opposite the lower end of the city of Cincinnati, for the purpose of obtaining data from which to locate a permanent gauge. This gauge is intended to give the pilots passing up the river the available headroom under the lowest bridge at Cincinnati, in order that timely preparation may be made for lowering the chimneys. It is expected that the permanent gauge will be erected within the next two months, and it will be of such a character that it can be read from the deck of a passing boat.

*High-water slope at Cincinnati.*—Advantage was taken of the high water of February, 1893, to establish a number of bench marks along the river front of Cincinnati from just below the mouth of the Little Miami River to Ludlow, Ky. These benches will be carefully connected by levels, and the slope thus accurately determined as having a bearing upon the establishment of harbor lines.

## STAGES OF THE OHIO RIVER DURING 1892–'93.

The following are the records of the gauges at Pittsburg, Cincinnati, and Evansville, which may be taken to represent the navigable condition of the Upper, Middle, and Lower Ohio:

### *Gauge of Davis Island Dam, near Pittsburg.*

[When the dam is up, low-water readings must be obtained from the gauge at the lower end of the lock. On this gauge 3 feet 2 inches corresponds to a navigable depth of 3 feet, and 6 feet corresponds to the same depth in the river.]

| Year and month. | Depth in channel. | | | Gauge readings. | |
|---|---|---|---|---|---|
| | Under 3 feet. | 3 feet and over. | 6 feet and over. | Highest. | Lowest. |
| **1892.** | *Days.* | *Days.* | *Days.* | *Feet.* | *Feet.* |
| July | 0 | 31 | 5 | 8.9 | 2.0 |
| August | 14 | 17 | 0 | 5.0 | 2.5 |
| September | 21 | 9 | 0 | 4.0 | 2.0 |
| October | 31 | 0 | 0 | 2.9 | 1.6 |
| November | 1 | 29 | 4 | 6.4 | 2.0 |
| December | 0 | 31 | 12 | 10.5 | 1.0 |
| **1893.** | | | | | |
| January | 0 | 31 | 5 | 14.2 | 2.6 |
| February | 0 | 28 | 28 | 22.3 | [illegible] |
| March | 0 | 31 | 31 | 16.3 | 7.3 |
| April | 0 | 30 | 30 | 17.1 | 7.3 |
| May | 0 | 31 | 31 | 19.0 | 6.6 |
| June | 1 | 26 | 3 | 6.4 | 2.9 |
| Total | 68 | 294 | 149 | | |

*Cincinnati gauge.*

[The zero of this gauge is about 2 feet below low water; readings of about 4 feet correspond to about 3 feet in the channel, and those of 7 feet to about 6 feet in the channel.]

| Year and month. | Depth in channel. | | | Gauge readings. | |
|---|---|---|---|---|---|
| | Under 3 feet. | 3 feet and over. | 6 feet and over. | Highest. | Lowest. |
| 1892. | *Days.* | *Days.* | *Days.* | *Feet.* | *Feet.* |
| July | 0 | 31 | 31 | 15.2 | 8.0 |
| August | 0 | 31 | 28 | 10.8 | 5.5 |
| September | 0 | 30 | 6 | 7.2 | 4.8 |
| October | 0 | 31 | 1 | 6.0 | 3.6 |
| November | 0 | 30 | 18 | 9.2 | 3.5 |
| December | 0 | 31 | 31 | 17.2 | 6.4 |
| 1893. | | | | | |
| January | 0 | 31 | 31 | 28.5 | 6.1 |
| February | 0 | 28 | 28 | 54.6 | 22.2 |
| March | 0 | 31 | 31 | 36.9 | 18.8 |
| April | 0 | 30 | 30 | 42.8 | 15.6 |
| May | 0 | 31 | 31 | 51.0 | 19.9 |
| June | 0 | 30 | 30 | 21.0 | 10.2 |
| Total | 0 | 365 | 296 | .......... | .......... |

*Evansville gauge.*

[The zero of this gauge is at the low-water line; readings of 2 feet correspond to about 3 feet in the channel, and readings of 6 feet correspond to about 6 feet in the channel.]

| Year and month. | Depth in channel. | | | Gauge readings. | |
|---|---|---|---|---|---|
| | Under 3 feet. | 3 feet and over. | 6 feet and over. | Highest. | Lowest. |
| 1892. | *Days.* | *Days.* | *Days.* | *Feet.* | *Feet.* |
| July | 0 | 31 | 30 | 13.3 | 5.7 |
| August | 0 | 31 | 6 | 6.9 | 4.1 |
| September | 8 | 22 | 0 | 4.5 | 2.7 |
| October | 28 | 3 | 0 | 3.0 | 1.3 |
| November | 18 | 12 | 0 | 5.1 | 1.1 |
| December | 0 | 31 | 17 | 13.5 | 5.2 |
| 1893. | | | | | |
| January | 0 | 31 | 25 | 11.8 | 5.0 |
| February | 0 | 28 | 28 | 41.8 | 11.7 |
| March | 0 | 31 | 31 | 36.5 | 16.0 |
| April | 0 | 30 | 30 | 31.9 | 13.8 |
| May | 0 | 31 | 31 | 40.3 | 20.6 |
| June | 0 | 30 | 30 | 25.3 | 8.4 |
| Total | 54 | 311 | 228 | | |

## OPERATION OF DRAWS IN HIGH BRIDGES.

There are no low draw bridges on the Ohio River; the general Ohio River bridge law requires that all bridges shall have a height of at least 40 feet above high water, and, since large steamboats require more than 40 feet, it is also provided that all bridges below the Cincinnati suspension bridge shall have a draw for use in high water, unless they give a clearance of at least 53 feet above high water. There are three high-water draws on the Ohio River, but the draw in the Ohio Falls Bridge, at Louisville, is exceptionally located, and no record of its operation is kept.

A report received from the Cincinnati Southern Railroad Bridge states that the draw was not opened for the passage of boats during the fiscal year.

### STOPPAGE OF NAVIGATION BY ICE.

Navigation at Cincinnati was entirely suspended by ice from January 3 to February 4. The condition of the river at this point is assumed as a fair average for the whole river.

### LOSSES BY COLLISION WITH BRIDGES.

The following tables show the losses sustained by the commerce of the Ohio River during the past fiscal year by collision with the piers of bridges crossing the Ohio River:

| Date. | Owner. | Steamboat. | Loss. | Amount. |
|---|---|---|---|---|
| Bellaire Bridge: | | | | |
| Previously reported | | | | $126,576.00 |
| Dec. 18, 1892 | Huntington and St. Louis Towboat Co. | H. F. Frisbie | 1 barge and cargo. | 8,580.00 |
| | Total | | | 135,156.00 |
| Cairo Bridge: | | | | |
| Previously reported | | | | 15,996.65 |
| Apr. 13, 1892 | Munhall Brothers | Joe. B. Williams | 2 coal boats | 7,500.00 |
| | Total | | | 23,496.65 |

*Losses by collision with Ohio River bridges to June 30, 1893.*

| | |
|---|---|
| Beaver Bridge | $56,040.00 |
| Steubenville Bridge | 90,308.00 |
| Wheeling and Martins Ferry Bridge | 9,800.00 |
| Bellaire Bridge | 135,156.00 |
| Parkersburg Bridge | 72,677.00 |
| Point Pleasant Bridge | 9,600.00 |
| Kenova Bridge | 18,760.00 |
| Newport and Cincinnati Railroad Bridge | 44,107.00 |
| Covington and Cincinnati Railroad Bridge | 43,300.00 |
| Cincinnati Southern Railroad Bridge | 9,812.00 |
| Ohio Falls Bridge | 80,350.00 |
| Kentucky and Indiana Bridge | 27,767.00 |
| Cairo Bridge | 23,496.65 |
| Henderson Bridge | 20,520.00 |
| Total | 641,633.65 |

The following estimate for appropriation is presented:

| | |
|---|---|
| Low dikes and dams | $600,000 |
| Repair, maintenance, and modification of existing structures | 50,000 |
| Two iron-hull dredges, fitted with tools for repair work | 70,000 |
| Four dump scows | 17,000 |
| Four fuel flats | 5,000 |
| Two decked flats | 5,000 |
| Two steamboats, tenders for dredges | 50,000 |
| Dredging work | 50,000 |
| Continuing work at mouth of Licking River | 10,000 |
| Special surveys | 10,000 |
| Various expenses, including establishment of harbor lines, expenses of boards of engineers, inspections of bridges, etc | 33,000 |
| General administration, engineering and inspection | 50,000 |
| For contingencies | 50,000 |
| | 1,000,000

### *Money statement.*

| | | |
|---|---|---|
| July 1, 1892, balance unexpended | | $58, 186. 44 |
| Transfer settlements | | 129. 40 |
| Amount appropriated by act approved July 13, 1892 | | 360, 000. 00 |
| | | 418, 315. 84 |
| June 30, 1893, amount expended during fiscal year | | 106, 787. 29 |
| July 1, 1893, balance unexpended | | 311, 528. 55 |
| July 1, 1893, outstanding liabilities | $15, 831. 31 | |
| July 1, 1893, amount covered by uncompleted contracts | 79, 979. 17 | |
| | | 95, 810. 48 |
| July 1, 1893, balance available | | 215, 718. 07 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895 | | 1, 000, 000. 00 |

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry-civil act of March 3, 1893.

*Abstract of proposals for furnishing towboat as tender to United States dredges Ohio and Oswego, received in response to advertisement dated August 6, 1892, and opened August 20, 1892, by Maj. Amos Stickney, Corps of Engineers.*

| No. | Name of bidder. | Price per day. |
|---|---|---|
| 1 | Steamer Delta and owners, per C. W. Posey | $45. 00 |
| 2 | Fulton Towboat Co | 42. 00 |
| 3 | Charles Hook, John Shoup | 43. 00 |
| 4 | J. P. Capehart | 45. 00 |
| 5 | E. J. Hulings, H. B. Hulings* | 39. 50 |

* Recommended for acceptance.

*Abstract of proposals for furnishing earth and completing Great Miami embankment at Lawrenceburg, Ind., received in response to advertisement dated September 19, 1892, and opened October 8, 1892, by Maj. Amos Stickney, Corps of Engineers.*

| No. | Name of bidder. | 35,000 cubic yards of earth, more or less. | Amount of bid. |
|---|---|---|---|
| | | *Per cubic yard.* | |
| 1 | John S. Dorman, James Johnson | $0. 19$\frac{7}{10}$ | $6, 895. 00 |
| 2 | Thomas T. Annis, Enoch McElfresh, Bailey H. Lowe, Columbus S. Guard* | . 18$\frac{1}{2}$ | 6, 475. 00 |
| 3 | John W. Scott & Co | . 21 | 7, 350. 00 |
| 4 | Charles L. Hayes, Oakey B. Nowlin, Peter Becker | . 20$\frac{11}{20}$ | 7, 192. 50 |
| 5 | William Kirk | . 22$\frac{1}{2}$ | 7, 875. 00 |

*Earth from borrow pit offered by city of Lawrenceburg, Ind. Recommended for acceptance.

*Abstract of proposals for furnishing towboat as tender to United States dredges Ohio and Oswego, received in response to advertisement dated March 14, 1893, and opened April 14, 1893, by Maj. Amos Stickney, Corps of Engineers.*

| No. | Name of bidder. | Price per day. |
|---|---|---|
| 1 | E. J. & H. B. Hulings* | $36. 50 |
| 2 | S. D. Davis | 43. 00 |
| 3 | Charles Hook, John Shoup | 40. 00 |

* Recommended for acceptance.

*Abstract of proposals for building dikes and dams in the Ohio River, received in response to advertisement dated April 29, 1893, and opened May 29, 1893, by Lieut. Col. Amos Stickney, Corps of Engineers.*

### WORK AT CLUSTERS.

| No. | Name of bidder. | Timber, 75,400 feet B. M. | | Piles, 624. | | Mats, 4,703 square yards. | | Binding poles, 4,110 linear feet. | |
|---|---|---|---|---|---|---|---|---|---|
| | | Bid. | Amount. | Bid. | Amount. | Bid. | Amount. | Bid. | Amount. |
| 1 | Lanphier Cramer and Jesse L. Cramer* | $20 | $1,508.00 | $2.50 | $1,560.00 | $0.60 | $2,821.80 | $0.02 | $82.20 |
| 4 | Joshua R. King | 24 | 1,809.60 | 4.60 | 2,870.40 | .75 | 3,527.25 | .10 | 411.00 |
| 5 | Sid. J. Truax | 45 | 3,393.00 | 5.00 | 3,120.00 | .90 | 4,232.70 | .02 | 82.20 |
| 9 | L. M. Petitdidier | 35 | 2,639.00 | 7.50 | 4,680.00 | 2.00 | 9,406.00 | .10 | 411.00 |
| 11 | Samuel Monroe | 36 | 2,714.40 | 5.50 | 3,432.00 | .65 | 3,056.95 | .12½ | 513.75 |
| 12 | Frank A. Bone | 26 | 1,960.40 | 6.00 | 3,744.00 | .84 | 3,950.52 | .05 | 205.50 |
| 13 | James R. Ware | 25 | 1,885.00 | 3.00 | 1,872.00 | 1.25 | 5,878.75 | .10 | 411.00 |

| No. | Name of bidder. | Stone. | | | | Bolts, 6,796 pounds. | | Spikes, 4 kegs. | | Total amount of bid. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Larger class, 315 cubic yards. | | Smaller class 13,482 cubic yards. | | | | | | |
| | | Bid. | Amount. | Bid. | Amount. | Bid. | Amount. | Bid. | Amount. | |
| 1 | Lanphier Cramer and Jesse L. Cramer.* | $1.00 | $315.00 | $0.85 | $11,459.70 | $0.05 | $339.75 | $6.00 | $24.00 | $18,110.45 |
| 4 | Joshua R. King | 1.25 | 393.75 | 1.00 | 13,482.00 | .07 | 475.65 | 7.50 | 30.00 | 22,999.65 |
| 5 | Sid. J. Truax | 5.00 | 1,575.00 | 2.00 | 26,964.00 | .20 | 1,359.00 | 6.00 | 24.00 | 40,749.90 |
| 9 | L. M. Petitdidier | 3.50 | 1,102.50 | 2.50 | 33,705.00 | .07 | 475.65 | 7.00 | 28.00 | 52,447.15 |
| 11 | Samuel Monroe | 2.50 | 787.50 | 1.70 | 22,919.40 | .07 | 475.65 | 4.50 | 18.00 | 33,917.65 |
| 12 | Frank A. Bone | 3.00 | 945.00 | 1.23 | 16,582.86 | .05 | 339.75 | 3.00 | 12.00 | 27,740.03 |
| 13 | James R. Ware | 3.00 | 945.00 | 1.25 | 16,852.50 | .09 | 611.55 | 10.00 | 40.00 | 28,495.80 |

* Recommended for acceptance.

### WORK AT FRENCH ISLAND.

| No. | Name of bidder. | Timber 48,200 feet, B. M. | | Piles, 384. | | Mats, 170 square yards. | | Binding poles, 195 linear feet. | |
|---|---|---|---|---|---|---|---|---|---|
| | | Bid. | Amount. | Bid. | Amount. | Bid. | Amount. | Bid. | Amount. |
| 1 | Lanphier Cramer and Jesse L. Cramer | $20 | $964.00 | $2.50 | $960.00 | $0.70 | $119.00 | $0.02 | $3.90 |
| 2 | Daniel Prosser and Tim Goulding | 25 | 1,205.00 | 10.00 | 3,840.00 | .95 | 161.50 | .05 | 9.75 |
| 3 | John J. Shipman | 40 | 1,928.00 | 8.00 | 3,072.00 | 1.50 | 255.00 | .15 | 29.25 |
| 5 | Sid J. Truax | 45 | 2,169.00 | 5.00 | 1,920.00 | .90 | 153.00 | .02 | 3.90 |
| 6 | John G. Eigenmann, Archibald Hollerbach, Jacob Eichel, and Jacob Arnold | 27 | 1,301.40 | 2.60 | 998.40 | .85 | 144.50 | .06 | 11.70 |
| 7 | William Kirk* | 30 | 1,446.00 | 4.00 | 1,536.00 | .40 | 68.00 | .05 | 9.75 |
| 9 | L. M. Petitdidier | 40 | 1,928.00 | 9.25 | 3,552.00 | 1.50 | 255.00 | .15 | 29.25 |
| 10 | Frederick Hartweg | 19 | 915.80 | 2.90 | 1,113.60 | 1.25 | 212.50 | .10 | 19.50 |
| 11 | Samuel Monroe | 36 | 1,735.20 | 5.50 | 2,112.00 | .65 | 110.50 | .12½ | 24.37 |
| 12 | Frank A. Bone | 25 | 1,205.00 | 6.00 | 2,304.00 | .80 | 136.00 | .05 | 9.75 |

*Abstract of proposals for building dikes and dams in the Ohio River, received in response to advertisement dated April 29, 1893, etc.*—Continued.

### WORK AT FRENCH ISLAND—Continued.

| No. | Name of bidder. | Stone. Larger class, 290 cubic yards. Bid. | Stone. Larger class, 290 cubic yards. Amount. | Stone. Smaller class, 9,756 cubic yards. Bid. | Stone. Smaller class, 9,756 cubic yards. Amount. | Bolts, 4,550 pounds. Bid. | Bolts, 4,550 pounds. Amount. | Spikes, 2 kegs. Bid. | Spikes, 2 kegs. Amount. | Total amount of bid. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Lanphier Cramer and Jesse L. Cramer | $1.10 | $319.00 | $0.94 | $9,170.64 | $0.05½ | $250.25 | $6.50 | $13.00 | $11,799.79 |
| 2 | Daniel Prosser and Tim Goulding | 3.00 | 870.00 | 2.00 | 19,512.00 | .08 | 364.00 | 10.00 | 20.00 | 25,982.25 |
| 3 | John J. Shipman | 4.00 | 1,160.00 | 2.00 | 19,512.00 | .10 | 455.00 | .10 | .20 | 26,411.45 |
| 5 | Sid J. Truax | 3.00 | 870.00 | 1.75 | 17,073.00 | .20 | 910.00 | 6.00 | 12.00 | 23,110.90 |
| 6 | John G. Eigenmann, Archibald Hollerbach, Jacob Eichel, and Jacob Arnold | 2.10 | 609.00 | 1.04 | 10,146.24 | .10 | 455.00 | 9.00 | 18.00 | 13,684.24 |
| 7 | William Kirk* | 1.00 | 290.00 | 1.00 | 9,756.00 | .07 | 318.50 | 2.00 | 4.00 | 13,428.25 |
| 9 | L. M. Petitdidier | 4.00 | 1,160.00 | 2.30 | 22,438.80 | .10 | 455.00 | 10.00 | 20.00 | 29,838.06 |
| 10 | Frederick Hartweg | 1.90 | 551.00 | 1.14 | 11,121.84 | .04 | 182.00 | 6.00 | 12.00 | 14,128.24 |
| 11 | Samuel Monroe | 2.50 | 725.00 | 1.70 | 16,585.20 | .07 | 318.50 | 4.50 | 9.00 | 21,619.77 |
| 12 | Frank A. Bone | 1.50 | 435.00 | 1.15 | 11,219.40 | .05 | 227.50 | 3.00 | 6.00 | 15,542.65 |

* Recommended for acceptance.

### WORK NEAR SCUFFLETOWN.

| No. | Name of bidder. | Timber, 63,600 feet, B. M. Bid. | Timber, 63,600 feet, B. M. Amount. | Piles, 542. Bid. | Piles, 542. Amount. | Mats, 1,944 square yards. Bid. | Mats, 1,944 square yards. Amount. | Binding poles, 1,680 linear feet. Bid. | Binding poles, 1,680 linear feet. Amount. |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Lanphier Cramer and Jesse L. Cramer* | $20 | $1,272.00 | $2.50 | $1,355.00 | $0.70 | $1,360.80 | $0.02 | $33.60 |
| 3 | John J. Shipman | 40 | 2,544.00 | 8.00 | 4,336.00 | 1.50 | 2,916.00 | .15 | 252.00 |
| 5 | Sid J. Truax | 45 | 2,862.00 | 5.00 | 2,710.00 | .90 | 1,749.60 | .02 | 33.60 |
| 7 | William Kirk | 30 | 1,908.00 | 4.00 | 2,168.00 | .40 | 777.60 | .05 | 84.00 |
| 9 | L. M. Petitdidier | 40 | 2,544.00 | 9.15 | 4,959.30 | 1.60 | 3,110.40 | .10 | 168.00 |
| 10 | Frederick Hartweg | 29 | 1,844.40 | 3.25 | 1,761.50 | 1.75 | 3,402.00 | .10 | 168.00 |
| 11 | Samuel Monroe | 36 | 2,289.60 | 5.50 | 2,981.00 | .65 | 1,263.60 | .12½ | 210.00 |
| 12 | Frank A. Bone | 25 | 1,590.00 | 6.00 | 3,252.00 | .80 | 1,555.20 | .05 | 84.00 |

| No. | Name of bidder. | Stone. Larger class, 100 cubic yards. Bid. | Stone. Larger class, 100 cubic yards. Amount. | Stone. Smaller class, 5,338 cubic yards. Bid. | Stone. Smaller class, 5,338 cubic yards. Amount. | Bolts, 4,942 pounds. Bid. | Bolts, 4,942 pounds. Amount. | Spikes, 2 kegs. Bid. | Spikes, 2 kegs. Amount. | Total amount of bid. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Lanphier Cramer and Jesse L. Cramer.* | $1.10 | $110.00 | $0.94 | $5,017.72 | $0.05½ | $271.81 | $6.50 | $13.00 | $9,433.93 |
| 3 | John J. Shipman | 4.00 | 400.00 | 2.25 | 12,010.50 | .10 | 494.20 | .10 | .20 | 22,952.90 |
| 5 | Sid J. Truax | 3.00 | 300.00 | 1.75 | 9,341.50 | .20 | 988.40 | 6.00 | 12.00 | 17,997.10 |
| 7 | William Kirk | 1.25 | 125.00 | 1.25 | 6,672.50 | .07 | 345.94 | 2.00 | 4.00 | 12,085.04 |
| 9 | L. M. Petitdidier | 3.75 | 375.00 | 2.50 | 13,345.00 | .08 | 395.36 | 7.50 | 15.00 | 24,912.06 |
| 10 | Frederick Hartweg | 1.90 | 190.00 | 1.24 | 6,619.12 | .04 | 197.68 | 6.00 | 12.00 | 14,194.70 |
| 11 | Samuel Monroe | 2.50 | 250.00 | 1.70 | 9,074.60 | .07 | 345.94 | 4.50 | 9.00 | 16,423.74 |
| 12 | Frank A. Bone | 1.50 | 150.00 | 1.15 | 6,138.70 | .05 | 247.10 | 3.00 | 6.00 | 13,023.00 |

* Recommended for acceptance.

*Abstract of proposals for building dikes and dams in the Ohio River, received in response to advertisement dated April 29, 1893, etc.*—Continued.

## WORK NEAR MOUTH OF TRADEWATER RIVER.

| No. | Name of bidder. | Timber, 59,000 feet, B. M. |  | Piles, 496. |  | Mats, 8,384 square yards. |  | Binding poles, 6,975 linear feet. |  |
|---|---|---|---|---|---|---|---|---|---|
|  |  | Bid. | Amount. | Bid. | Amount. | Bid. | Amount. | Bid. | Amount. |
| 3 | John J. Shipman | $40.00 | $2,360.00 | $8.00 | $3,968.00 | $1.50 | $12,576.00 | $0.15 | $1,046.25 |
| 7 | William Kirk* | 27.50 | 1,622.50 | 3.50 | 1,736.00 | .30 | 2,515.20 | .05 | 348.75 |
| 8 | Evan Davis and Henry C. Spencer | 35.00 | 2,065.00 | 9.00 | 4,464.00 | .95 | 7,964.80 | .05 | 348.75 |
| 9 | L. M. Petitdidier | 40.00 | 2,360.00 | 9.50 | 4,712.00 | 1.50 | 12,576.00 | .18 | 1,255.50 |
| 10 | Frederick Hartweg | 19.00 | 1,121.00 | 2.90 | 1,438.40 | 1.35 | 11,318.40 | .10 | 697.50 |
| 11 | Samuel Monroe | 40.00 | 2,360.00 | 5.50 | 2,728.00 | .75 | 6,288.00 | .12½ | 871.87 |
| 12 | Frank A. Bone | 25.00 | 1,475.00 | 6.00 | 2,976.00 | .80 | 6,707.20 | .05 | 348.75 |

| No. | Name of bidder. | Stone. |  |  |  | Bolts, 4,294 pounds. |  | Spikes, 1 keg. |  | Total amount of bid. |
|---|---|---|---|---|---|---|---|---|---|---|
|  |  | Larger class, 50 cubic yards. |  | Smaller class, 4,411 cubic yards. |  |  |  |  |  |  |
|  |  | Bid. | Amount. | Bid. | Amount. | Bid. | Amount. | Bid. | Amount. |  |
| 3 | John J. Shipman | $4.00 | $200.00 | $1.75 | $7,719.25 | $0.10 | $429.40 | $0.10 | $0.10 | $28,299.00 |
| 7 | William Kirk* | .90 | 45.00 | .90 | 3,969.90 | .07 | 300.58 | 2.00 | 2.00 | 10,539.93 |
| 8 | Evan Davis and Henry C. Spencer | 4.00 | 200.00 | 1.85 | 8,160.35 | .06 | 257.64 | 3.50 | 3.50 | 23,464.04 |
| 9 | L. M. Petitdidier | 3.50 | 175.00 | 2.00 | 8,822.00 | .08 | 343.52 | 8.00 | 8.00 | 30,252.02 |
| 10 | Frederick Hartweg | 1.90 | 95.00 | .98 | 4,322.78 | .04 | 171.76 | 6.00 | 6.00 | 19,170.84 |
| 11 | Samuel Monroe | 2.50 | 125.00 | 1.75 | 7,719.25 | .07 | 300.58 | 4.50 | 4.50 | 20,397.20 |
| 12 | Frank A. Bone | 2.00 | 100.00 | 1.40 | 6,175.40 | .05 | 214.70 | 3.00 | 3.00 | 18,000.05 |

* Recommended for acceptance.

## WORK NEAR MOUND CITY.

| No. | Name of bidder. | Timber, 51,000 feet, B. M. |  | Piles, 430. |  | Mats, 4,574 square yards. |  | Binding poles, 3,735 linear feet. |  |
|---|---|---|---|---|---|---|---|---|---|
|  |  | Bid. | Amount. | Bid. | Amount. | Bid. | Amount. | Bid. | Amount. |
| 9 | L. M. Petitdidier | $40 | $2,040.00 | $15.00 | $6,450.00 | $2.00 | $9,148.00 | $0.15 | $560.25 |
| 10 | Frederick Hartweg* | 16 | 816.00 | 2.70 | 1,161.00 | 1.19 | 5,443.06 | .10 | 373.50 |
| 11 | Samuel Monroe | 40 | 2,040.00 | 5.50 | 2,365.00 | .75 | 3,430.50 | 12½ | 466.87 |

| No. | Name of bidder. | Stone. |  |  |  | Bolts, 3,759 pounds. |  | Spikes, 1 keg. |  | Total amount of bid. |
|---|---|---|---|---|---|---|---|---|---|---|
|  |  | Larger class. 105 cubic yards. |  | Smaller class, 5,671 cubic yards. |  |  |  |  |  |  |
|  |  | Bid. | Amount. | Bid. | Amount. | Bid. | Amount. | Bid. | Amount. |  |
| 9 | L. M. Petitdidier | $4.00 | $420.00 | $2.50 | $14,177.50 | $0.09 | $338.31 | $9.00 | $9.00 | $33,143.06 |
| 10 | Frederick Hartweg* | 2.25 | 236.25 | 1.49 | 8,449.79 | .04 | 150.36 | 6.00 | 6.00 | 16,635.96 |
| 11 | Samuel Monroe | 2.50 | 262.50 | 1.75 | 9,924.25 | .07 | 263.13 | 4.50 | 4.50 | 18,756.75 |

* Recommended for acceptance.

*Abstract of proposals for dwelling at Davis Island Dam, Ohio River, received in response to advertisement dated May 13, 1893, and opened June 14, 1893, by Lieut. Col. Amos Stickney, Corps of Engineers.*

| No. | Name of bidder. | Frame house, complete. |
|---|---|---|
| 1 | C. W. Brockunier | $3,640 |
| 2 | H. A. Kunze | 4,125 |
| 3 | William Wolfshafer* | 3,550 |
| 4 | J. G. Braden | 4,621 |

*Recommended for acceptance.

*Abstract of contracts.*

| Contractor. | Work of improvement. | Date of contract. | To expire— |
|---|---|---|---|
| E. J. Hulings and H. B. Hulings. | Furnishing towboat for United States dredges. | Aug. 30, 1892 | At close of season. |
| Thomas T. Annis, Enoch McElfresh, Bailey H. Lowe, and Columbus S. Guard. | Furnishing earth and completing Great Miami embankment at Lawrenceburg, Ind. | Oct. 29, 1892 | May 2, 1893, extended to July 2, 1893. |
| E. J. Hulings and H. B. Hulings. | Furnishing towboat for United States dredges. | May 8, 1893 | At close of season. |
| L. Cramer & Son........ | Building four dikes and one dam and shore protection at Clusters. | June 20, 1893 | Dec. 31, 1893. |
| William Kirk.......... | Building two dikes and one dam at French Island. | ...do........ | Do. |
| William Kirk.......... | Building one dike near mouth of Tradewater River. | ...do........ | Do. |
| Frederick Hartweg.... | Building two dikes near Mound City...... | ...do........ | Do. |
| L. Cramer & Son........ | Building two dikes near Scuffletown...... | ...do........ | Do. |
| William Wolfshafer... | Building frame house as quarters for employés on Davis Island. | July 1, 1893 | 5 months from date of approval. |

OHIO RIVER COMMERCE.

The last annual report of the superintendent of the Cincinnati Chamber of Commerce contains much valuable information concerning the commerce of the Ohio River, and the following extracts are made as being especially interesting in connection with the statistics given below:

"The general aspect of the year has not been favorable to river transportation interests of this city. The business of September, October, and the greater part of November was seriously interfered with by low water, and not until the first part of December was the trade fully represented. * * *

"Owing to the class of freights, such as iron, nails, and glassware, the Pittsburg trade compares favorably with previous years, and shows even a large increase the past three years. This is probably accounted for by the withdrawal of the through lines from Pittsburg to St. Louis and the system of towboats. The past year, however, shows a decided increase in the barge system of transportation, and corresponding decrease in our regular trade, as the following statement of business handled by towboat companies owned by Cincinnati companies will show:

| | | | | | |
|---|---|---|---|---|---|
| Salt...................... | barrels.. | 62,000 | Spikes................. | kegs.. | 1,000 |
| Steel rails.................. | tons.. | 20,000 | Pig iron................ | tons.. | 10,000 |
| Cotton ties.................. | do .. | 12,000 | Potatoes ........... | barrels.. | 50,000 |
| Manufactured iron.......... | do .. | 1,000 | Brick........................ | | 2,363,000 |
| Nails...................... | kegs.. | 12,000 | Staves........................ | | 24,000,000 |

"The year opened with 17 feet of water at Cincinnati and falling, and continued to decline steadily until November 15, necessarily cutting off the most profitable season in river transportation, being the time for a general movement of agricultural products. After the 15th, conditions were favorable, and December 1 found all lines in full operation, with only a fair business, and the same working forces as the previous year.

"There were six vessels in the Pittsburg trade, making daily departures, except Wednesday; three to Pomeroy, with daily departures; one weekly packet to the Kanawha River; triweekly to Portsmouth; daily to Maysville and Chilo, except Sunday; daily to Madison, except Sunday; daily to Louisville; two boats each week to Memphis, and one each week to New Orleans. A light run of ice in January caused some interruption, but only for a few days.

"High water in the lower Mississippi seriously interrupted trade with the Southern Transportation Line, and early in the season trade was practically abandoned, making only twenty-three departures during the year.

"The highest stage of water at Cincinnati was 43 feet 8 inches, April 25, and from this point the river receded steadily until the close of the year. Early in July the Pittsburg and Memphis trades were abandoned, and the Louisville Mail Line was the only one continuing to the close of the year without interruption. * * *

"One new boat has been added to the Pittsburg trade, and one destroyed in the Southern Transportation Line. The steamer *Golden Rule*, of this line, was burned at the wharf March 31, 1892, on the eve of departure for New Orleans, causing a loss of six lives and total loss of cargo and vessel. These are the only changes during the year in the Cincinnati trade." * * *

### *Coal shipments from Pittsburg, Pa.*

[Furnished by Capt. William Evans.]

| Month. | To Cincinnati. | | | | | To Louisville. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Trips. | Coal boats. | Coal barges. | Fuel flats. | Tons. | Trips. | Coal boats. | Coal barges. | Fuel flats. | Tons. |
| January | 13 | 29 | 122 | ....... | 88,992 | 11 | 34 | 101 | 9 | 87,168 |
| February | 16 | 5 | 192 | ....... | 94,446 | 36 | 137 | 341 | 8 | 275,278 |
| March | 27 | 16 | 330 | 4 | 162,100 | 34 | 215 | 214 | 8 | 288,312 |
| April | 22 | 6 | 275 | 3 | 136,700 | 23 | 94 | 197 | 13 | 185,295 |
| May | 26 | 24 | 316 | 8 | 178,961 | 37 | 109 | 379 | 28 | 298,127 |
| June | 12 | 9 | 138 | 2 | 75,350 | 11 | 35 | 109 | 5 | 84,977 |
| July | 11 | 9 | ........ | 145 | 73,587 | 8 | 4 | 104 | 16 | 53,205 |
| December | 20 | 20 | 16 | 172 | 104,294 | 19 | 62 | 92 | 19 | 112,592 |
| Total | 147 | 118 | 1,389 | 334 | 914,430 | 179 | 690 | 1,537 | 106 | 1,384,864 |
| Grand total | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 2,299,294 |

### *Comparative table showing coal shipments from Pittsburg during the nine years ending December 31, 1892.*

| Year. | To Cincinnati. | To Louisville. | Total. |
|---|---|---|---|
| | *Tons.* | *Tons.* | *Tons.* |
| 1884 | 946,124 | 1,160,292 | 2,106,416 |
| 1885 | 1,733,104 | 1,114,008 | 2,847,112 |
| 1886 | 1,262,702 | 2,220,530 | 3,483,232 |
| 1887 | 788,690 | 1,367,012 | 2,155,702 |
| 1888 | 1,950,882 | 2,223,494 | 4,174,376 |
| 1889 | 1,149,892 | 1,439,747 | 2,589,639 |
| 1890 | 1,324,641 | 2,095,716 | 3,420,357 |
| 1891 | 1,065,705 | 1,828,047 | 2,893,752 |
| 1892 | 914,430 | 1,384,864 | 2,299,294 |

### *Commerce passing Davis Island dam in 1892.*

| Vessels. | Ascending. | | | | Descending. | | | | Total freight. |
|---|---|---|---|---|---|---|---|---|---|
| | Through lock. | Freight. | Through pass. | Freight. | Through lock. | Freight. | Through pass. | Freight. | |
| | *No.* | *Tons.* | *No.* | *Tons.* | *No.* | *Tons.* | *No.* | *Tons.* | *Tons.* |
| Packets | 75 | 4,740 | 381 | 42,365 | 74 | 3,983 | 373 | 36,218 | 87,306 |
| Towboats | 261 | ......... | 1,311 | ......... | 247 | ......... | 1,309 | ......... | ......... |
| Model barges | 2 | ......... | 83 | ......... | 2 | ......... | 79 | 61,800 | 61,800 |
| Coal boats | 92 | ......... | 515 | ......... | 1 | ......... | 1,069 | 976,599 | 976,599 |
| Barges | 490 | 2,557 | 3,092 | 26,324 | 36 | 7,252 | 3,454 | 1,747,600 | 1,783,733 |
| Flats | 370 | 1,658 | 1,081 | 17,360 | 301 | 18,340 | 1,472 | 278,296 | 315,654 |
| Rafts | ......... | ......... | 2 | ......... | 23 | 8,433 | 60 | 210,395 | 218,828 |
| Miscellaneous | 32 | ......... | 80 | ......... | 48 | ......... | 97 | ......... | ......... |
| Total | 1,322 | 8,955 | 6,545 | 86,049 | 732 | 38,008 | 7,913 | 3,310,908 | 3,442,920 |

*River commerce of Cincinnati for year ending August 31, 1892.*

| Articles. | Receipts. | Shipments. | Total. | Articles. | Receipts. | Shipments. | Total. |
|---|---|---|---|---|---|---|---|
| | *Tons.* | *Tons.* | *Tons.* | | *Tons.* | *Tons.* | *Tons.* |
| Alcohol | | 61 | 61 | Iron, scrap | 186 | | 186 |
| Ale and beer | 6 | 1,941 | 1,947 | Lead, pig | 16 | 1 | 17 |
| Apples | 3,670 | 558 | 4,228 | Lead, white | | 344 | 344 |
| Bagging | | 112 | 112 | Leather | 330 | 152 | 482 |
| Barley | 17 | | 17 | Lemons | 7 | 74 | 81 |
| Beans | 101 | 155 | 256 | Lime | 601 | 606 | 1,207 |
| Beef | | 4 | 4 | Lumber | 5,080 | 860 | 5,940 |
| Boots and shoes | 15 | 394 | 409 | Malt | 50 | 309 | 359 |
| Bran, etc | 278 | 169 | 447 | Manufactures | | 139 | 139 |
| Broom corn | 1 | 6 | 7 | Merchandise | 85,878 | 25,638 | 111,516 |
| Butter | 91 | 7 | 98 | Molasses | 4,130 | 1,707 | 5,837 |
| Candles | | 8 | 8 | Nails | 18,604 | 13,246 | 31,850 |
| Castings | 1,013 | 1,077 | 2,090 | Oats | 37 | 371 | 408 |
| Cattle | 3,470 | 182 | 3,652 | Oil | 482 | 1,124 | 1,606 |
| Cement | 3,163 | 1,614 | 4,777 | Onions | 60 | 213 | 273 |
| Cheese | 2 | 56 | 58 | Oranges | | 401 | 401 |
| Cider | 395 | 308 | 703 | Peanuts | 922 | 377 | 1,299 |
| Coffee | 6 | 1,217 | 1,223 | Petroleum | 586 | 952 | 1,538 |
| Cooperage | 421 | 406 | 827 | Potatoes | 5,498 | 5,402 | 10,900 |
| Corn | 2,780 | 375 | 3,155 | Rice | 889 | 173 | 1,062 |
| Corn meal | 15 | 210 | 225 | Rope | 3,198 | 6,690 | 9,888 |
| Cotton | 9,764 | 281 | 10,045 | Rosin | 1 | 103 | 104 |
| Crockery | 270 | 485 | 755 | Rye | 271 | 77 | 348 |
| Eggs | 648 | 64 | 712 | Salt | 19,304 | 11,580 | 30,884 |
| Feathers | 42 | 7 | 49 | Seed, clover, and timothy | 233 | 994 | 1,227 |
| Fish | 5 | 527 | 532 | Sheep | 1,083 | 13 | 1,096 |
| Fish, kegs and kits | 1 | 174 | 175 | Shot | 2 | 182 | 184 |
| Flour | 543 | 2,302 | 2,845 | Soap | 29 | 375 | 404 |
| Fruit, dried | 196 | 59 | 255 | Sorghum | 841 | 24 | 865 |
| Fruit, green | 897 | 2 | 899 | Spices | 4 | 14 | 18 |
| Furniture | | 824 | 824 | Starch | 6 | 112 | 118 |
| Glass, window | 180 | 109 | 289 | Stearine | | 1 | 1 |
| Glassware | 3,733 | 3,311 | 7,044 | Sugar | 713 | 2,682 | 3,395 |
| Grease | 542 | 118 | 660 | Tallow | 356 | 56 | 412 |
| Hardware | 2,778 | 4,526 | 7,304 | Tobacco | 16,862 | 3,308 | 20,170 |
| Hay | 3,432 | 284 | 3,716 | Turpentine | | 23 | 23 |
| Hides | 283 | 118 | 401 | Vegetables | 383 | 128 | 511 |
| Hog product | 16 | 2,321 | 2,337 | Vinegar | | 1,371 | 1,371 |
| Hogs | 8,653 | 6 | 8,659 | Wheat | 5,892 | 1,221 | 7,113 |
| Hops | | 5 | 5 | Whisky | 8,098 | 6,390 | 14,488 |
| Horses | 665 | 629 | 1,294 | Wines and liquors | 336 | 463 | 799 |
| Iron | 42,349 | 39,053 | 81,402 | Wool | 134 | 84 | 218 |
| Iron, pig | 9,832 | 16,116 | 25,948 | Yarn, cotton | 317 | | 317 |

*Recapitulation.*

| | Tons. |
|---|---|
| Receipts | 281,692 |
| Shipments | 168,161 |
| Total | 449,853 |

*Arrivals and departures of steamboats at the port of Cincinnati, Ohio.*

| Year. | Arrivals. | | | | Departures. | | | |
|---|---|---|---|---|---|---|---|---|
| | From New Orleans. | From Pittsburg. | From other ports. | Total. | For New Orleans. | For Pittsburg. | For other ports. | Total. |
| 1885-'86 | 63 | 103 | 2,323 | 2,489 | 66 | 103 | 2,314 | 2,483 |
| 1886-'87 | 34 | 69 | 2,169 | 2,272 | 38 | 70 | 2,173 | 2,281 |
| 1887-'88 | 35 | 156 | 1,389 | 1,580 | 37 | 153 | 1,385 | 1,575 |
| 1888-'89 | 51 | 237 | 2,233 | 2,521 | 51 | 237 | 2,234 | 2,522 |
| 1889-'90 | 38 | 197 | 2,022 | 2,257 | 37 | 194 | 2,021 | 2,252 |
| 1890-'91 | 31 | 208 | 1,995 | 2,234 | 31 | 207 | 1,996 | 2,234 |
| 1891-'92 | 23 | 204 | 1,958 | 2,185 | 23 | 202 | 1,963 | 2,188 |

*Schedule of rates on flour per barrel by rail and river from Cincinnati for six years ending August 31, 1892.*

| Year. | To Pittsburg. | | To Louisville. | | To New Orleans. | | To Memphis. | |
|---|---|---|---|---|---|---|---|---|
| | By rail. | By river. | By rail. | By river. | By rail. | By river. | By rail. | By river. |
| | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* |
| 1886 | 26 to 31 | 15 to 20 | 15 | 15 | 44 | 35 to 39 | ........ | ........ |
| 1887 | 24 to 31 | 15 | 15 | 15 | 44 to 49 | 35 | ........ | ........ |
| 1888 | 22 to 24 | 15 | 15 | 15 | 40 to 49 | 35 | ........ | ........ |
| 1889 | 23 | 15 | 15 | 15 | 54 | 35 | ........ | ........ |
| 1890 | 23 to 24 | 15 | 15 | 15 | 49 to 54 | 35 | ........ | ........ |
| 1891 | 24 | 15 | 15 | 15 | 49 | 35 | ........ | ........ |
| 1892 | 24 | 15 | 15 | 15 | 49 | 35 | 40 | 30 |

*Comparative statement of commerce passing the falls of the Ohio River by canal and by river.*

| Years. | Canal. | | Open river. | | Total. | |
|---|---|---|---|---|---|---|
| | Vessels. | Tons. | Vessels. | Tons. | Vessels. | Tons. |
| 1882 | 3,988 | 935,628 | 2,305 | 668,866 | 6,293 | 1,604,494 |
| 1883 | 5,231 | 1,349,115 | 1,484 | 483,281 | 6,715 | 1,832,396 |
| 1884 | 3,485 | 785,192 | 1,548 | 484,124 | 5,033 | 1,269,316 |
| 1885 | 5,678 | 1,443,181 | 822 | 262,862 | 6,500 | 1,706,043 |
| 1886 | 4,964 | 1,240,112 | 1,796 | 577,547 | 6,760 | 1,817,659 |
| 1887 | 4,069 | 867,807 | 2,297 | 1,204,518 | 6,366 | 2,072,325 |
| 1888 | 6,963 | 1,915,365 | 2,252 | 1,162,305 | 9,215 | 3,077,670 |
| 1889 | 5,534 | 1,404,573 | 1,984 | 957,829 | 7,518 | 2,362,402 |
| 1890 | 4,386 | 998,062 | 3,828 | 1,717,158 | 8,214 | 2,715,220 |
| 1891 | 4,739 | 1,302,471 | 2,137 | 1,062,428 | 6,876 | 2,364,899 |
| 1892 | 5,506 | 1,275,329 | 1,826 | 858,953 | 7,332 | 2,134,282 |

*Commerce of Ohio River in 1892.*

| Name of boat or company. | Between what points on the Ohio River. | Distance on Ohio River. | Number of months in commission. | Freight. | Number of passengers. |
|---|---|---|---|---|---|
| | | | | *Tons.* | |
| **Coal shipments from Pittsburg** | **Pittsburg to Cairo** | **965** | **8** | **2,299,294** | ........ |
| **Tennessee River Navigation Co.** | **......do** | **965** | **5** | **18,838** | ........ |
| **Huntington & St. Louis Towboat Co.** | **......do** | **965** | **6** | **125,040** | ........ |
| **A. Montgomery & Co** | **......do** | **965** | **11** | **469,356** | ........ |
| **John Barrett & Son** | **......do** | **965** | **9** | **183,500** | ........ |
| **Relief Towboat Co** | **......do** | **965** | **8** | **37,500** | ........ |
| **Steamer Hawk** | **Pittsburg to Cincinnati** | **467** | **3** | **20,369** | ........ |
| **Steamer Lizzie Bay** | **......do** | **467** | **10** | **7,000** | **6,000** |
| **Steamer Iron Queen** | **......do** | **467** | **5** | **14,350** | **6,925** |
| **Steamer Keystone State** | **......do** | **467** | **8½** | **24,800** | **11,200** |
| **Steamer Andes** | **......do** | **467** | **6½** | **9,230** | **1,690** |
| **Steamer Hudson** | **......do** | **467** | **9** | **15,643** | **4,370** |
| **Steamer Scotia** | **......do** | **467** | **6** | **10,000** | **3,000** |
| **Steamer Courier** | **Pittsburg to Parkersburg** | **183** | **8** | **12,480** | **6,369** |
| **Steamer Ben Hur** | **......do** | **183** | **8½** | **7,911** | **8,925** |
| **Steamer Sunshine** | **......do** | **183** | **1½** | **2,040** | **1,349** |
| **Steamer Annie Laurie** | **......do** | **183** | **5** | **3,000** | **2,500** |
| **Steamer Elaine** | **......do** | **183** | **12** | **38,840** | **387** |
| **Steamer H. K. Bedford** | **Pittsburg to Wheeling** | **90** | **8½** | **6,500** | **3,000** |
| **Steamer C. W. Batchelor** | **......do** | **90** | **4** | **1,600** | **2,500** |
| **Hulings Bros** | **Pittsburg to Bellaire** | **94** | **4** | **60,200** | ........ |
| **Steamer Leni Leoti** | **Pittsburg to McKees Rocks** | **3½** | **11** | **755** | **73,759** |
| **Steamer Venus** | **......do** | **3½** | **11** | **715** | **70,871** |
| **Steamer Venice** | **......do** | **3½** | **8** | **369** | **38,231** |
| **Steamer Olivette** | **Liverpool to Wheeling** | **46** | **8** | **956** | **2,596** |
| **Steamer R. E. Phillips** | **Wheeling to Bellaire** | **4** | **10** | **1,500** | **40,000** |
| **Steamer Liberty** | **Wheeling to Clarington** | **28** | **11** | **4,740** | **10,268** |
| **Steamer Eliza H** | **Bellaire to Parkersburg** | **89** | **10** | **28,000** | ........ |
| **Steamer T. N. Barnsdall** | **Matamoras to Marietta** | **30** | **9** | **5,000** | **10,800** |
| **Steamer C. C. Martin** | **Marietta to Middleport** | **78½** | **1½** | **821** | **276** |

### *Commerce of Ohio River in 1892*—Continued.

| Name of boat or company. | Between what points on the Ohio River. | Distance on Ohio River. | Number of months in commission. | Freight. | Number of passengers. |
|---|---|---|---|---|---|
| | | | | *Tons.* | |
| Steamer Matt F. Allen | Marietta to Gallipolis | 96 | 5 | 4,550 | 2,000 |
| Steamer Crown Hill | Parkersburg to Cincinnati | 283 | 10 | 40,000 | .......... |
| Steamer Harry D. Knox | Parkersburg to Ravenswood | 35 | 8 | 2,400 | 6,000 |
| Steamer Valley Belle | Ravenswood to Middleport | 34 | 8 | 5,160 | 8,769 |
| J. R. Ware | Ravenswood to Cincinnati | 247 | 12 | 27,112 | .......... |
| Steamer Capitol City | Racine to Gallipolis | 32 | 9 | 9,000 | 2,940 |
| Syracuse Coal and Salt Co | Syracuse to Cincinnati | 224 | 9 | 22,000 | .......... |
| Steamer Pilgrim | Pomeroy to Huntington | 43 | 7 | .......... | 15,660 |
| Cincinnati and Pomeroy Packet Co.* | Pomeroy to Cincinnati | 219 | 10 | 157,791 | 45,985 |
| Steamer Jessie | do | 219 | 7 | 700 | .......... |
| Pomeroy, Cincinnati and Louisville Barge Line. | do | 219 | 9 | 115,650 | .......... |
| Steamer J. M. Clark | do | 219 | 7 | 21,000 | .......... |
| The Marmet Co | Point Pleasant to Louisville. | 336 | 9 | 128,047 | .......... |
| Sea Lion Towboat Co | do | 336 | 8 | 600,250 | .......... |
| Ella Layman Towboat Co | do | 336 | 5 | 222,185 | .......... |
| Armstrong Bros | do | 336 | 6 | 80,000 | .......... |
| Steamer J. H. McConnell | Point Pleasant to Cincinnati. | 208 | 10 | 65,000 | .......... |
| Collier, Budd & Co | do | 203 | 10 | 49,680 | .......... |
| Kanawha and Ohio Transportation Co. | do | 203 | 9 | 144,145 | .......... |
| Steamer Henry M. Stanley | do | 203 | 10 | 15,826 | 7,518 |
| Steamer Carrie Brown | Gallipolis to Huntington | 99 | 10½ | 4,740 | 16,033 |
| Steamer Louise | Proctorville to Portsmouth. | 53 | 6 | 9,000 | 2,700 |
| Steamer B. T. Enos | do | 53 | 6 | 6,000 | 3,000 |
| Steamer Chevalier | Huntington to Ironton | 19 | 9¾ | 15 | 29,400 |
| Steamer Georgia | do | 19 | 2 | .......... | 3,000 |
| Steamer Lee H. Brooks | Huntington to Portsmouth | 47 | 5 | 5 | 3,790 |
| Thomas J. Hall | Ashland to New Albany | 283 | 10 | 20,000 | .......... |
| Ashland Coal and Iron Rwy. Co. | Ashland to Portsmouth | 33 | 10 | 5,000 | .......... |
| Steamer Reliance | Portsmouth to Rome | 27 | 10 | 5,815 | 5,909 |
| Buena Vista Freestone Co | Buena Vista to Cincinnati | 95 | 12 | 20,000 | .......... |
| Steamer Silver Wave | Vanceburg to Maysville | 30 | 9 | 16,800 | 12,600 |
| R. H. Fleming | Manchester to Ludlow | 75 | 12 | 15,660 | .......... |
| Cincinnati Sand and Gravel Co. | Manchester to Addyston | 86 | 8 | 6,000 | .......... |
| John Trapp | Maysville to Covington | 61 | 10 | 20,000 | .......... |
| Steamer Henrietta | Maysville to Louisville | 193 | 9 | .......... | 3,470 |
| Steamer Tacoma | Chilo to Cincinnati | 35 | 9 | 10,800 | 29,600 |
| Steamer Rob Roy | Moscow to Cincinnati | 27 | 9 | 26,000 | .......... |
| Coney Island Co | Coney Island to Cincinnati | 10 | 3 | 1,000 | 350,000 |
| Steamer Bellevue | Dayton to Cincinnati | 3 | 10 | .......... | 242,801 |
| Henry Spille & Son | do | 3 | 6 | 12,000 | .......... |
| Comet Towboat Co | Cincinnati and vicinity | .......... | 11 | 120,000 | .......... |
| Steamer Alice Barr | do | .......... | 9 | 146,000 | .......... |
| Steamer Levi J. Workum | Cincinnati to Petersburg | 25 | 12 | 6,122 | 994 |
| Steamer F. J. O'Connell | Cincinnati to Carrollton | 75 | 10 | 18,000 | .......... |
| U. S. Mail Line Co† | Cincinnati to Louisville | 132 | 12 | 143,007 | 111,255 |
| Steamer B. F. Young | Cincinnati to Paducah | 455 | 1 | 1,790 | 5 |
| Memphis & Cincinnati Pkt. Co. | Cincinnati to Cairo | 499 | 8 | 67,953 | 12,183 |
| Steamer Guiding Star | do | 499 | 5½ | 15,000 | 2,191 |
| Steamer New Mary Houston | do | 499 | 5 | 8,000 | 675 |
| Steamer State of Kansas | do | 499 | 5 | 7,400 | 340 |
| Steamer State of Missouri | do | 499 | 6 | 12,400 | 500 |
| Steamer U. P. Schenck | do | 499 | 1 | 597 | 38 |
| Steamer Ghent | Lawrenceburg to Carrollton. | 52 | 8 | 72,400 | 7,800 |
| Steamer Katie Prather | do | 52 | 6 | 32,300 | 2,500 |
| Steamer City of Clarksville | Carrollton to Louisville | 58 | 4 | 4,960 | 4,680 |
| Steamer Falls City | do | 58 | 11 | 17,600 | 14,300 |
| Steamer Jim Montgomery | Madison to Bethlehem | 17 | 10 | 2,400 | 8,000 |
| Steamer Robt. B. Carson | Louisville to West Point | 25½ | 1 | 640 | 41 |
| Steamer Racket | Louisville to Derby | 88 | 3½ | 400 | 50 |
| Steamer Henry Logan | do | 88 | 10 | 9,060 | 200 |
| Steamer Little Albert | Louisville to Evansville | 185½ | 10 | 3,000 | .......... |
| Louisville and Evansville Mail Line Co. | Louisville to Henderson | 197 | 12 | 116,548 | 36,519 |
| Steamer Stone Wave | Louisville to Paducah | 322½ | 3 | 78 | .......... |
| Owensboro and Cannelton Pkt. Co. | Cannelton to Owensboro | 32 | 12 | 6,065 | 17,550 |
| Steamer Eugene | Cannelton to Paducah | 203 | 10 | 18,000 | .......... |
| Steamer Emma Cooper | do | 203 | 10 | 12,000 | .......... |
| Steamer Frank Stein | Owensboro to Henderson | 46 | 11 | 5,280 | 13,560 |
| Steamer Royal | do | 46 | 11 | 7,698 | 47,488 |

* One boat to Pittsburg. One boat to Manchester.

† Two boats to Madison. One boat Patriot to Madison. One boat Carrollton to Louisville.

*Commerce of Ohio River in 1892*—Continued.

| Name of boat or company. | Between what points on the Ohio River. | Distance on Ohio River. | Number of months in commission. | Freight. | Number of passengers. |
|---|---|---|---|---|---|
| | | | | *Tons.* | |
| John Ingle & Co | Mouth Green River to Evansville. | 8 | 10 | 300,000 | 2,000 |
| Steamer T. C. Woodward | do | 8 | 10½ | 460 | 3,700 |
| Evansville, Paducah and Tennessee River Pkt. Co. | Evansville to Paducah | 137 | 10 | 8,000 | 3,000 |
| Steamer Joe Fowler | do | 137 | 12 | 16,725 | 16,220 |
| Steamer John S. Hopkins | do | 137 | 11½ | 14,500 | 15,922 |
| Steamer Rosedale | do | 137 | 12 | 11,900 | 1,800 |
| The Ohio and Mississippi Towing Co. | Evansville to Cairo | 182 | 8 | 32,600 | .......... |
| Steamer D. A. Brooks | Shawneetown to Paducah | 73 | 12 | 80,000 | 103 |
| Steamer Albert S. Willis | Shawneetown to Cairo | 118½ | 10 | 25,500 | .......... |
| Steamer Monie Bauer | Caseyville to Paducah | 60½ | 8 | 4,025 | 365 |
| Steamer Maggie Belle | Caseyville to Cairo | 105½ | 6 | 5,000 | .......... |
| Steamer Fannie | Elizabethtown to Paducah | 43 | 6 | 4,300 | 1,236 |
| Steamer Edwin J. Woods | Elizabethtown to Cairo | 88 | 1½ | 1,200 | .......... |
| Steamer Corinne No. 2 | do | 88 | 9 | 75,000 | .......... |
| Steamer City of Metropolis | Paducah to Metropolis | 9 | 12 | 2,300 | 18,000 |
| Steamer Fred. Nellis | Paducah to Cairo | 45 | 7 | 5,000 | .......... |
| Steamer Luella Brown | do | 45 | 10 | 500 | 17,500 |
| Steamer Gus Fowler | do | 45 | 12 | 21,192 | 8,650 |
| Steamer City of Savannah | do | 45 | 11 | 19,700 | 9,100 |
| Steamer City of Sheffield | do | 45 | 8 | 18,500 | 1,065 |
| Steamer Coal Bluff | Point Pleasant to Cincinnati | 202 | 9 | 100,350 | .......... |
| Total | | .......... | .......... | 6,901,186 | 1,476,363 |

*Tonnage from which no report can be obtained (estimated).*

| | Tons. |
|---|---|
| Logs, lumber, and railroad ties towed and rafted | 1,000,000 |
| Flatboats: Corn, oats, hay, apples, potatoes, cabbage, cider, tan bark, hoop poles, etc | 50,000 |
| Trading boats: Glass and stoneware, dry goods, groceries, oil, hides, pelts, oil barrels, scrap iron, old rope, etc | 15,000 |
| Total | 1,065,000 |

## REPORT OF BOARD OF ENGINEERS UPON IMPROVEMENT OF OHIO RIVER AT LOGSTOWN BAR.

PITTSBURG, PA., *June 9, 1893.*

GENERAL: The Board of Engineer officers, constituted by Special Orders No. 1, paragraph 1, headquarters Corps of Engineers, U. S. Army, January 10, 1893, to consider and report upon a project for improving the channel of the Ohio River at Logstown Bar, met at Pittsburg on June 8 and 9, 1893. On June 8 the board, in company with a large number of representatives of the Coal Exchange of Pittsburg and of the packet companies, masters, pilots, and others interested in the improvement of the Ohio River, made a thorough examination of the Ohio River in the vicinity of Logstown Bar, and, in accordance with previous notice, a public meeting was held. A committee, appointed by the Coal Exchange and the Pilots' Association, and many individual owners, masters, and pilots, appeared before the board, and all interested parties were given an opportunity to express their opinions as to the proposed improvement.

Having given full consideration to all the information presented, the board presents the following report:

A training dike, similar to those heretofore in general use on the Ohio

River, was constructed for the improvement of Logstown Bar many years ago. It is claimed that such dike, while up to its full height, maintained a channel sufficient for purposes of coal navigation, and gave a better low-water channel than was found at many other points on the Ohio, but that the gradual lowering of the dike from the effect of ice and other natural causes has destroyed its efficiency and made the Logstown Bar a serious obstruction to navigation.

A project for the improvement of the channel of the Ohio River at Logstown Bar, 18 miles below Pittsburg, presented by Lieut. Col. Amos Stickney, Corps of Engineers, under date of December 20, 1892, as modified by him under date of January 4, 1893, is presented to the board for consideration. This project proposes a modification of the system of improvement heretofore followed, by the substitution of spur dikes for the training dike, and the formation of a proper low-water channel, as well as the maintaining of a channel suitable to purposes of coal navigation. Spur dikes are recommended, for the reason that they will be more effectual than training dikes in causing a movement of the obstructive material from the channel of the river to holding ground between the dams, and result in the building up of new banks and keeping the low-water flow in a more uniform and properly proportioned channel. It is proposed to form a low-water channel with least width of 400 feet and central depth of 4 feet at low-water stage, by the construction of low spur dikes of loose stone and by dredging. Three spurs, as shown on blue prints accompanying project, are proposed: two from the left bank (A and C) and one from the right bank (B). The tops of dikes A and B are placed one foot below the low-water surface. The top of dike C, outside of the old dike, is placed at low water, and the portion between the shore and the old dike is to be built to a height of 4 feet above low water. The project proposes using the stone from the old training dike for the new dikes, and so lowering the old dike as to make it no material obstruction to the flow of the water.

It is the expressed desire of those interested in the transportation of coal and others interested in navigation, that the old training dike be restored to its original condition, it being claimed that experience has shown that while such dike was maintained no difficulties were experienced at Logstown Bar. Objection is made to the new plan proposed, on the ground that the dredging work will be liable to lower the pools above and develop new obstructions; that the spur dikes will not be as effectual as the training dike in holding up the water surface, and more difficult and dangerous to run over; that the portion of spur dike C projecting beyond the line of the old training dike will be an objection, and that spur dike B will interfere with the use of the low-water channel along the right bank of the river, and of much used landing places. It is also desired by the river interests that an old stone dike on the right bank above Logstown Bar be removed by dredging, to facilitate the entrance to the low-water channel.

The board is of the opinion that the representatives of the Pittsburg Coal Exchange and the Pilots' Association hold erroneous opinions as to the probable effect of the spur dikes, but that the necessities of the improvement and the results to be secured by the complete carrying out of the work contemplated by the project, are not sufficiently great to justify any work which is unanimously opposed by those for whose benefit it is projected. This opinion is strengthened by the fact that the present improvement of Logstown Bar is a temporary matter, such obstruction being included in the stretch of the Ohio to be eventually improved by locks and dams.

The board would recommend that the project presented for its consideration be modified in the following particulars: That spur dam B and the portion of spur dam C not yet commenced, be omitted; that the portion of spur dam C between the shore and the old training dike and the extension of about 100 feet beyond training dike, upon which portion of dike work has been commenced, be built up to a height of 5 feet above low water, and that a training dike of same height be built from the end of this dike down stream to the gravel bar below, such spur and training dike to take the place of the old training dike; that the dredging of a channel through the bar be limited, as much as possible, to such work as may be necessary for bringing the bed of the river to approximately the condition it was at the time the old training dike was in repair. Dam A is not objected to by the interests of navigation, and it is recommended that it be constructed as proposed.

All of which is respectfully submitted:

C. B. COMSTOCK,
*Colonel, Corps of Engineers, Bvt. Brig. Gen., U. S. A.*
AMOS STICKNEY,
*Lieut. Col., Corps of Engineers.*
A. MACKENZIE,
*Major, Corps of Engineers.*

Brig. Gen. THOMAS L. CASEY,
*Chief of Engineers, U. S. A.*

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
*June 21, 1893.*

Approved.

THOS. LINCOLN CASEY,
*Brig. Gen., Chief of Engineers.*

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## F F 2.

## OPERATING SNAG BOATS ON OHIO RIVER.

The river and harbor act of September 19, 1890, contained the following item:

> SEC. 13. That for the purpose of securing the uninterrupted work of operating snag boats on the Ohio River, and removing snags, wrecks, and other obstructions in said river, the Secretary of War, upon the application of the Chief of Engineers, is hereby authorized to draw his warrant or requisition from time to time upon the Secretary of the Treasury for such sums as may be necessary to do such work, not to exceed in the aggregate for each year the sum of twenty-five thousand dollars: *Provided, however,* That an itemized statement of said expenses shall accompany the Annual Report of the Chief of Engineers.

The object of the above provision was undoubtedly to provide funds for the constant operating of the snag boat in the most efficient manner, without subjecting her important service to the uncertainties arising from the failure of yearly appropriations. The provision is one of great importance to the navigation interests of the Ohio River, and the work of the snag boat in removing snags and wrecks has done much toward increasing the safety and ease of navigation. The amount of $25,000 per year, which is authorized to be expended for this service, is not sufficient to keep the boat employed for the length of time that she should be each year, and to provide for repairs. The boat is well adapted for her work, but the work is very heavy and necessitates much renewal of various parts of machinery and outfit, besides the boat is getting old and requires considerable repairs each year to keep her in effective working condition. To keep within the amount allotted it is necessary to lay the boat up for a part of the year when she might be usefully employed, and some parts of the river are not visited as often as they should be. I would earnestly recommend that the amount to be available each year should be increased to $50,000, or so much of that amount as might be necessary. With that amount the boat would be kept constantly in highly effective condition, could start out early enough each season to go over the entire river at least once and most of the distance twice, and would make her service entirely satisfactory to the navigation interests.

The repairs to snag boat prior to commencing the season's work in 1892 were those only which were of the most urgent character. The boat worked from August 8 to December 16, 1892, and in that time removed 532 snags, 1 rock, and 45 wrecks. The boat traveled 2,121½ miles, much of that distance being traversed at a time when the water was so low that navigation in general was of necessity suspended. The boat was ordered into winter quarters in the Kentucky River, when she went out of commission December 19, 1892. The present report is for the calendar year 1892, and the report of expenditures covers the fiscal year from July 1, 1892, to June 30, 1893. Absolutely necessary repairs having been made, the boat left Cincinnati June 27, 1893, and at the close of the year was near Pittsburg to commence the season's work.

The work of the snag boat has been under the supervision of Capt. W. H. Christian.

### OPERATIONS.

[Extract from the report of Capt. W. H. Christian.]

The snag boat remained in winter quarters until July 4, 1892, when she was removed to Cincinnati, Ohio, to undergo some needed repairs before commencing her season's work of removing obstructions from the Ohio River.

Owing to the small annual allotment of money allowed the boat for operating expenses and repairs, and the lateness of the season, coupled with a strong desire to put the boat to work as soon as possible after funds became available, only such repairs were made to the boat as were indispensable to put her in passable condition for service; therefore, a number of very necessary repairs were passed for a more favorable time in the future to make them. In consequence thereof the snag boat was obliged, along with other things left undone, to carry through the year, nonerected, two large new capstans and capstan engines, the services of which had been greatly needed during the work of former seasons, and whose services were frequently and seriously needed in the work of the present year. These machines were contracted for in May and delivered to the boat in September, 1891.

August 8, 1892, temporary repairs being completed, the snag boat *Woodruff* left Cincinnati and ascended the river until reaching a point opposite the Three Brothers Islands, about 158 miles below Pittsburg, where she begun the work of removing two sunken coal barges. After removing the barges, the water being too low to proceed farther up the river, the boat was headed downstream, commencing and continuing the removal of snags, rocks, wrecks, and other obstructions, until October 22, when Indiana Bar, 915 miles below Pittsburg, was reached, where, owing to extreme low water (12 inches less than the draft of the boat), she was compelled to lie at the bank above the bar until November 14, when a rise in the Tennessee River backed the water up in the Ohio River sufficiently to permit the *Woodruff*, with the aid of light sparring, to pass over the bar and resume her snagging operations as far as Cairo, the southern limit of her district, 966 miles below Pittsburg. In this connection I desire to state that the river was so low from August 8, the time of starting, until October 22, the time of temporary suspension at Indiana Bar, that the *Woodruff* had to be sparred over all the notably bad crossings between the Three Brothers Islands and Indiana Bar, covering a distance of 715 miles, and from the Sisters Islands to Indiana Bar the water was so low, sparring so hard, and progress so slow that the *Woodruff*, although working from twelve to fifteen hours daily, traveled only 18 miles in six days.

The time spent at Indiana Bar wating for a rise in the river was not lost to the service, as the crew was employed in making needed repairs to the machinery, and in cleaning and painting, to preserve the iron hull and other parts of the boat and her outfit, which want of time did not permit doing at the commencement of the season.

On arrival at Cairo, November 17, a rise was reported in the upper Ohio. On the 18th the *Woodruff* left Cairo, and worked upstream as far as the old mouth of the Scioto River, 356 miles below Pittsburg, when (after removing the remains of a coal boat recently sunk in a collision between the towboats *J. A. Blackmore* and *George Matheson*) owing to a scarcity of funds and too high water for economical or successful snagging, the boat was ordered into winter quarters in the mouth of Kentucky River, where she went out of commission December 19, 1892. After the boat was put in order for winter all of the crew, except those usually retained to take care of the property, were suspended and ordered to leave the boat until she was commissioned for the next season's work.

The snag boat *E. A. Woodruff* was in commission one hundred and thirty-one days from August 8 to December 16, 1892, and was employed as follows:

| | Days. |
|---|---|
| Snagging and wrecking | 82 |
| Wrecking, exclusively | 8 |
| Sparring and incidental repairs | 3 |
| Sundays, tied up | 18 |
| At Indiana Bar | 20 |

During the eighty-two days credited to snagging, wrecking, etc., the snag boat dragged a number of landings without finding any obstructions, traveled 2,121½ miles, and removed 532 snags, 1 rock, and 45 wrecks.

Among the snags removed were the following:

| | Weight in tons. |
|---|---|
| 1 from channel in front of Portsmouth | 42.833 |
| 1 from channel in front of Grays Landing | 40.166 |
| 1 from channel in front of Cheathams Point | 79.100 |
| 1 from channel below Bowlesville | 41.900 |
| 1 from channel below Bowlesville | 52.400 |
| 1 from channel below Bowlesville | 72.430 |
| 1 from channel below Bowlesville | 78.720 |
| 1 from channel below Bowlesville | 45.833 |
| 1 from channel in front of Hurricane Island Towhead | 82.350 |
| 1 from channel Hurricane Island Chute | 48.266 |
| 1 from channel in front of Stone Fence Landing | 52.200 |
| 1 from channel in front of Widow Stewarts | 53.540 |
| 1 from channel at foot of Hughes Bar | 69.166 |

Also 1 from Indiana Bar which sank the Evansville and Cairo Packet Company's steamer *E. G. Ragon*.

The wrecks removed are classified as follows:

| | |
|---|---|
| Coal boats, barges, and flats | 35 |
| Steamboat hulls | 4 |
| Steam ferryboat hull | 1 |
| Wharf boat hull | 1 |
| Model barge hulls | 2 |
| Stone boat hull | 1 |
| Crane boat hull | 1 |

All of the obstructions removed had seriously increased the perils of navigation, and some had caused much uneasiness and trouble to navigators and a loss of property, before the *Woodruff*, due to lack of funds, could be put into commission to remove them.

*Itemized statement of expenses for operating snag boats on the Ohio River, and removing snags, wrecks, and other obstructions in said river.*

EXPENSES OF U. S. SNAG BOAT E. A. WOODRUFF.

| Month. | Pay of crew. | Subsistence. | Fuel. | Miscellaneous supplies. | Tools and implements. | General repairs. | Contingent expenses. | Total. |
|---|---|---|---|---|---|---|---|---|
| 1892. | | | | | | | | |
| July | $1,391.32 | $56.08 | $69.20 | $0.60 | $10.87 | $558.56 | $46.55 | $2,133.18 |
| August | 2,081.96 | 646.54 | 306.98 | 357.28 | 132.21 | 657.11 | 15.85 | 4,197.43 |
| September | 2,013.78 | 474.36 | 355.88 | 74.10 | 6.12 | 418.09 | 4.00 | 3,346.33 |
| October | 1,927.63 | 416.95 | 115.75 | 17.91 | .......... | .......... | 72.46 | 2,550.70 |
| November | 1,942.15 | 590.12 | 326.02 | 41.04 | .......... | 12.28 | 153.35 | 3,064.96 |
| December | 1,431.92 | 178.10 | 284.85 | 81.69 | .......... | 21.66 | 3.75 | 2,001.97 |
| 1893. | | | | | | | | |
| January | 400.00 | 17.22 | .......... | .......... | .......... | .......... | .......... | 417.22 |
| February | 404.00 | 37.61 | 100.00 | .......... | 1.00 | .......... | 1.00 | 543.61 |
| March | 759.52 | 25.67 | .......... | 10.75 | 3.96 | 58.90 | 20.00 | 878.79 |
| April | 1,122.77 | .......... | 36.57 | .......... | .......... | 579.20 | .40 | 1,738.94 |
| May | 898.69 | .......... | 35.10 | 136.15 | 84.39 | 919.44 | 54.50 | 2,078.27 |
| June | 807.76 | 106.85 | 198.65 | 15.50 | .......... | 11.34 | 14.40 | 1,154.50 |
| Total | 15,181.50 | 2,549.50 | 1,820.00 | 735.02 | 188.54 | 3,236.58 | 335.76 | 24,105.90 |

## F F 3.

## OPERATING AND CARE OF DAVIS ISLAND DAM, OHIO RIVER, NEAR PITTSBURG, PA.

This work has been under the immediate supervision of Mr. William Martin, assistant engineer.

The following is a statement of the amount and date of all allotments for this work:

| Date | Amount | Date | Amount |
|---|---|---|---|
| August 3, 1885 | $5,865.00 | May 19, 1890 | $2,000.00 |
| July 10, 1886 | 12,015.00 | June 17, 1890 | 14,752.00 |
| January 28, 1887 | 6,700.00 | October 7, 1890 | 14,800.00 |
| July 1, 1887 | 12,355.00 | July 10, 1891 | 10,338.00 |
| February 25, 1888 | 3,500.00 | July 23, 1892 | 11,831.48 |
| July 11, 1888 | 18,015.00 | June 27, 1893 | 1,300.00 |
| August 20, 1889 | 12,073.00 | | |

At the close of the last fiscal year the dam was up, having been raised on June 30, 1892. The maneuvers during the year were as follows:

Lowered the dam July 3.
Raised the dam July 11.
Lowered the dam December 2.
Raised the dam June 13.

The dam was thus raised and lowered twice and was up one hundred and sixty-four days. At the end of the year the dam was up.

Owing to the breaking of an axle of one of the rollers and the axle timbers under the lower gate, December 2, 1892, the gate was disabled and the use of lock suspended until repairs could be made. The dam was lowered and the repairs completed before the use of the lock was again required. An extension of the guiding crib below the lock, for a distance of 305 feet, was completed during the year. This crib is of a construction similar to the old crib which it prolongs, and the lower end of new crib is 600 feet below the lock gate. The ice of the winter of 1892–'93 carried away a portion of the lower slope of the permanent dam between Davis Island and south bank of river. A new service pump for supplying the water tanks was erected during the year.

[illegible] has been replaced by [illegible]

[illegible] there was 2 feet of water [illegible] get off, and [illegible] The owners of the boat have [illegible]

[illegible] during the year in the system of [illegible] from the Weather Bureau the [illegible] in the evening from [illegible] and one on the Yough-[illegible]

[illegible] house has decayed so [illegible] Drawings of a design for an awning in [illegible] work of building and erecting has been [illegible]

[illegible] guiding crib of the lock, which has been the subject of former recommendations, was built in the fall of 1892 from funds allotted from the Ohio River appropriation, costing $4,449.84. The old crib is 250 feet long from the lower end of the lock wall, which point is 25 feet below the lock gate, 17 feet high, and 15 feet wide. It is of timber crib work and filled with riprap stone. The extension is of similar construction, 305 feet long and 11 feet 6 inches high, with a gap of 20 feet between the old and new cribs, making the distance of the lower end of the new crib 600 feet below the lock gate. This improvement is apparent during the short time the lock has been in operation since its construction, as boats enter and leave the lock without any difficulty.

*Bar below the lock.*—The bar which has existed below the lock for several years has been removed by the Ohio River dredges, working from June 2 until the 9th. The removal of this bar, together with the extension of the lower guiding crib, renders the passage of boats to and from the lock very easy.

*Natural gas.*—Our supply of natural gas for light and fuel is still received from the Bellevue and Glenfield Natural Gas Company, at the same rate per annum as paid last year, viz, $350.

*Operation of dam.*—The dam was up on July 1, 1892, and was maneuvered during the year on the following dates: Lowered July 3 and December 2, 1892; raised July 11, 1892, and June 13, 1893.

Duration in days of the various stages of water in the Ohio River at the Davis Island Dam from October 7, 1885, to the close of the fiscal year June 30, 1893, is shown by the accompanying table.

| Month. | 1885-'86. | | | 1886-'87. | | | 1887-'88. | | | 1888-'89. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Under 3 feet. | 3 feet and over. | 6 feet and over. | Under 3 feet. | 3 feet and over. | 6 feet and over. | Under 3 feet. | 3 feet and over. | 6 feet and over. | Under 3 feet. | 3 feet and over. | 6 feet and over. |
| July | ...... | ...... | ...... | 7 | 24 | 0 | 21 | 10 | 0 | 3 | 28 | 8 |
| August | ...... | ...... | ...... | 7 | 24 | 3 | 27 | 4 | 0 | 13 | 18 | 6 |
| September | ...... | ...... | ...... | 19 | 11 | 0 | 30 | 0 | 0 | 1 | 29 | 6 |
| October | 12 | 19 | 7 | 26 | 5 | 0 | 30 | 1 | 0 | 1 | 30 | 23 |
| November | 0 | 30 | 22 | 12 | 18 | 16 | 19 | 11 | 0 | 0 | 30 | 26 |
| December | 0 | 31 | 27 | 0 | 31 | 22 | 2 | 29 | 0 | 0 | 31 | 18 |
| January | 0 | 31 | 28 | 0 | 31 | 17 | 1 | 30 | 19 | 0 | 31 | 30 |
| February | 0 | 28 | 21 | 0 | 28 | 28 | 0 | 29 | 26 | 0 | 28 | 13 |
| March | 0 | 31 | 17 | 0 | 31 | 18 | 0 | 31 | 29 | 0 | 31 | 29 |
| April | 0 | 30 | 21 | 0 | 30 | 13 | 0 | 30 | 25 | 0 | 30 | 25 |
| May | 0 | 31 | 11 | 0 | 31 | 16 | 0 | 31 | 13 | 0 | 31 | 21 |
| June | 2 | 28 | 5 | 3 | 27 | 7 | 1 | 29 | 2 | 0 | 30 | 30 |
| Year | 14 | 259 | 150 | 74 | 291 | 140 | 181 | 235 | 114 | 18 | 347 | 235 |

| Month. | 1889-'90. | | | 1890-'91. | | | 1891-'92. | | | 1892-'93. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Under 3 feet. | 3 feet and over. | 6 feet and over. | Under 3 feet. | 3 feet and over. | 6 feet and over. | Under 3 feet. | 3 feet and over. | 6 feet and over. | Under 3 feet. | 3 feet and over. | 6 feet and over. |
| July | 0 | 31 | 13 | 14 | 17 | 1 | 0 | 31 | 13 | 0 | 31 | 5 |
| August | 5 | 26 | 2 | 13 | 18 | 9 | 0 | 31 | 12 | 14 | 17 | 0 |
| September | 18 | 12 | 0 | 0 | 30 | 21 | 9 | 21 | 4 | 21 | 9 | 0 |
| October | 6 | 25 | 3 | 0 | 31 | 31 | 20 | 11 | 0 | 31 | 0 | 0 |
| November | 0 | 30 | 30 | 0 | 30 | 29 | 9 | 21 | 7 | 1 | 29 | 2 |
| December | 0 | 31 | 31 | 0 | 31 | 17 | 0 | 31 | 29 | 0 | 31 | 12 |
| January | 0 | 31 | 31 | 0 | 31 | 31 | 0 | 31 | 22 | 0 | 31 | 6 |
| February | 0 | 28 | 28 | 0 | 28 | 28 | 0 | 29 | 27 | 0 | 28 | 28 |
| March | 0 | 31 | 31 | 0 | 31 | 31 | 0 | 31 | 29 | 0 | 31 | 31 |
| April | 0 | 30 | 26 | 0 | 30 | 26 | 0 | 30 | 30 | 0 | 30 | 30 |
| May | 0 | 31 | 31 | 1 | 30 | 0 | 0 | 31 | 29 | 0 | 31 | 31 |
| June | 0 | 30 | 21 | 0 | 30 | 21 | 0 | 30 | 22 | 1 | 29 | 3 |
| Year | 29 | 336 | 247 | 28 | 337 | 245 | 38 | 328 | 224 | 68 | 297 | 148 |

### OPERATIONS DURING THE FISCAL YEAR.

[Extract from the Report of Mr. William Martin.]

*Lock.*—At the beginning of the year the lock was in good order and working satisfactorily. On December 2 the lower lock gate, which had been working unsatisfactorily for several days previous, became disabled. This occurred when the gate was in the recess, and all efforts to close it were without avail. An examination of the gate developed the fact that the outer axle was broken, the lower wheel of the second axle was off and the axle out of its bearings and jammed in such a manner that the gate could not be moved. The upper and lower wheel timbers, 8 by 14 inches in size, to which the axle bearings are secured, were broken for a length embracing three axles. The iron plate, $\frac{3}{16}$ inch by 7 inches, which forms the gate seat and is secured to the bottom of the screen, was torn off and injured so as to render it unfit for further use. As the gate was in the recess at the time it became disabled, it was necessary to make the repairs as it stood, and as the recess is very contracted, there being only 9 inches clearance on each side of the gate, it made the work very difficult to perform. In order to make the repairs it was necessary to raise the gate off the track; this was done as follows: Fourteen 12-inch by 12-inch timbers were laid on the top of the wall spanning the recess, through each of which four long screw bolts passed, two on each side of the gate, extending down and passing through a stirrup beneath the gate truss. By this means the gate was lifted off the track 30 inches, permitting access beneath. The broken axle, which was 3¾ inches in diameter, has been renewed by one 4¼ inches in diameter; the wheel of the second axle, which was recovered in the river, has been replaced; the iron plate, $\frac{3}{16}$ inch by 7 inches, forming the gate seat was so badly broken that it has been renewed by one ¼ inch by 7 inches; the broken wheel timbers, which were of pine, were renewed with oak for a length of 26 feet; and in addition an iron plate ¼ inch thick by 14 inches wide has been added, which adds increased strength.

The design of these lock gates is such that no provision was made for the lateral movement, which is necessary to relieve the friction of the seat against the track sill. In the absence of this provision the gate slides laterally on its wheels, which creates a great strain on the lower part of the structure, making it difficult to keep the wheels and axles in proper alignment. The two outer lock-discharging valves in the gate have been inoperative since the tug links for the gate chain have been put in, which has interfered with their action. On account of this interference these valves have been taken out of the gate, considerably reducing the weight. The lower lock gate, which is so much heavier than the upper, on account of having the discharging valves in it, has been the cause of very expensive repairs, and until the gate is remodeled to overcome the sliding lateral movement referred to, little relief can be expected.

*Service pump.*—The new power service pump, which was in process of erection at the close of last year, was completed July 14. The pump is a double plunger, operated by a 25-inch turbine wheel from the power created by the movable dam and, of course, can only be used when the dam is up. It has worked very satisfactorily since it has been in service.

*Back River Dam.*—This dam is a permanent structure closing the back channel between Davis Island and the south shore. It has a length of 457 feet. The ice of last winter cut away about two-thirds of the lower slope and also the apron. It is important that this work be repaired the coming summer, as another winter might so injure it as to require a complete renewal.

*Movable dam.*—In raising the dam on the 12th of June, the first time of the season, Wicket No. 19 was discovered missing. It has evidently been struck by an ascending boat and broken from its fastenings to the horse. It has been replaced by a new one. With this exception there has been no injury to the Chanoine Dam.

On the evening of February 16 the towboat *Return*, ascending the river, ran onto the north bear-trap pier. At the time of the occurrence there was 2 feet of water over the pier. The boat ran on the pier so far as to require one hour to get off, and in doing so displaced a number of the coping stone. The owners of the boat have offered to pay the expenses of making the repairs.

*River gauge stations.*—There has been no change during the year in the system of receiving flood warnings. We receive in the morning from the Weather Bureau the report from all the principal tributaries, seventeen in all, and in the evening from five stations: two on the Allegheny, two on the Monongahela, and one on the Youghiogheny River.

*Lockkeepers' house.*—The upper porch of the lockkeepers' house has decayed so badly as to make its removal necessary. Drawings of a design for an awning in place of the porch have been made, and the work of building and erecting has been given to Messrs. Ritter & Conley.

*Lower guiding crib.*—The extension of the lower guiding crib of the lock, which has been the subject of former recommendations, was built in the fall of 1892 from funds allotted from the Ohio River appropriation, costing $4,449.84. The old crib is 250 feet long from the lower end of the lock wall, which point is 25 feet below the lock gate, 17 feet high, and 15 feet wide. It is of timber crib work and filled with riprap stone. The extension is of similar construction, 305 feet long and 11 feet 6 inches high, with a gap of 20 feet between the old and new cribs, making the distance of the lower end of the new crib 600 feet below the lock gate. This improvement is apparent during the short time the lock has been in operation since its construction, as boats enter and leave the lock without any difficulty.

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*Natural gas.*—Our supply of natural gas for light and fuel is still received from the Bellevue and Glenfield Natural Gas Company, at the same rate per annum as paid last year, viz, $350.

*Operation of dam.*—The dam was up on July 1, 1892, and was maneuvered during the year on the following dates: Lowered July 3 and December 2, 1892; raised July 11, 1892, and June 13, 1893.

Duration in days of the various stages of water in the Ohio River at the Davis Island Dam from October 7, 1885, to the close of the fiscal year June 30, 1893, is shown by the accompanying table.

| Month. | 1885–'86. | | | 1886–'87. | | | 1887–'88. | | | 1888–'89. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Under 3 feet. | 3 feet and over. | 6 feet and over. | Under 3 feet. | 3 feet and over. | 6 feet and over. | Under 3 feet. | 3 feet and over. | 6 feet and over. | Under 3 feet. | 3 feet and over. | 6 feet and over. |
| July | ...... | ...... | ...... | 7 | 24 | 0 | 21 | 10 | 0 | 3 | 28 | 8 |
| August | ...... | ...... | ...... | 7 | 24 | 3 | 27 | 4 | 0 | 13 | 18 | 6 |
| September | ...... | ...... | ...... | 19 | 11 | 0 | 30 | 0 | 0 | 1 | 29 | 6 |
| October | 12 | 19 | 7 | 26 | 5 | 0 | 30 | 1 | 0 | 1 | 30 | 23 |
| November | 0 | 30 | 22 | 12 | 18 | 16 | 19 | 11 | 0 | 0 | 30 | 26 |
| December | 0 | 31 | 27 | 0 | 31 | 22 | 2 | 29 | 0 | 0 | 31 | 18 |
| January | 0 | 31 | 28 | 0 | 31 | 17 | 1 | 30 | 19 | 0 | 31 | 30 |
| February | 0 | 28 | 21 | 0 | 28 | 28 | 0 | 29 | 26 | 0 | 28 | 13 |
| March | 0 | 31 | 17 | 0 | 31 | 18 | 0 | 31 | 29 | 0 | 31 | 29 |
| April | 0 | 30 | 21 | 0 | 30 | 13 | 0 | 30 | 25 | 0 | 30 | 25 |
| May | 0 | 31 | 11 | 0 | 31 | 16 | 0 | 31 | 13 | 0 | 31 | 21 |
| June | 2 | 28 | 5 | 3 | 27 | 7 | 1 | 29 | 2 | 0 | 30 | 30 |
| Year | 14 | 259 | 159 | 74 | 291 | 140 | 131 | 235 | 114 | 18 | 347 | 235 |

| Month. | 1889–'90. | | | 1890–'91. | | | 1891–'92. | | | 1892–'93. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Under 3 feet. | 3 feet and over. | 6 feet and over. | Under 3 feet. | 3 feet and over. | 6 feet and over. | Under 3 feet. | 3 feet and over. | 6 feet and over. | Under 3 feet. | 3 feet and over. | 6 feet and over. |
| July | 0 | 31 | 13 | 14 | 17 | 1 | 0 | 31 | 13 | 0 | 31 | 5 |
| August | 5 | 26 | 2 | 13 | 18 | 9 | 0 | 31 | 12 | 14 | 17 | 0 |
| September | 18 | 12 | 0 | 0 | 30 | 21 | 9 | 21 | 4 | 21 | 9 | 0 |
| October | 6 | 25 | 3 | 0 | 31 | 31 | 20 | 11 | 0 | 31 | 0 | 0 |
| November | 0 | 30 | 30 | 0 | 30 | 29 | 9 | 21 | 7 | 1 | 29 | 2 |
| December | 0 | 31 | 31 | 0 | 31 | 17 | 0 | 31 | 29 | 0 | 31 | 12 |
| January | 0 | 31 | 31 | 0 | 31 | 31 | 0 | 31 | 22 | 0 | 31 | 6 |
| February | 0 | 28 | 28 | 0 | 28 | 28 | 0 | 29 | 27 | 0 | 28 | 28 |
| March | 0 | 31 | 31 | 0 | 31 | 31 | 0 | 31 | 29 | 0 | 31 | 31 |
| April | 0 | 30 | 26 | 0 | 30 | 26 | 0 | 30 | 30 | 0 | 30 | 30 |
| May | 0 | 31 | 31 | 1 | 30 | 0 | 0 | 31 | 29 | 0 | 31 | 31 |
| June | 0 | 30 | 21 | 0 | 30 | 21 | 0 | 30 | 22 | 1 | 29 | 3 |
| Year | 29 | 336 | 247 | 28 | 337 | 245 | 38 | 328 | 224 | 68 | 297 | 148 |

*Detailed statement of expenses incurred at the Davis Island Dam, Ohio River, during the fiscal year ending June 30, 1893.*

| Month. | Operating expenses. | | | | Maintenance and repairs. | | | | | Grand total. |
|---|---|---|---|---|---|---|---|---|---|---|
| | Salaries. | Supplies. | Miscellaneous expenses. | Total. | Labor. | Material. | Plant. | | Total. | |
| | | | | | | | Purchase and repairs. | Hire. | | |
| 1892. | | | | | | | | | | |
| July | $690.50 | $88.83 | $122.00 | $901.33 | ....... | $117.49 | $2.03 | ....... | $119.52 | $1,020.85 |
| August | 724.75 | 85.57 | 111.67 | 871.99 | ....... | ........ | ........ | ....... | ........ | 871.99 |
| September | 500.00 | 24.33 | 62.40 | 586.73 | ....... | ........ | 40.48 | ....... | 40.48 | 627.21 |
| October | 706.66 | ....... | 50.60 | 757.26 | ....... | ........ | ........ | ....... | ........ | 757.26 |
| November | 500.00 | 87.50 | 332.00 | 919.50 | ....... | .66 | 1,112.12 | ....... | 1,112.78 | 2,032.28 |
| December | 700.00 | 2.90 | 142.03 | 844.93 | ....... | ........ | ........ | ....... | ........ | 844.93 |
| 1893. | | | | | | | | | | |
| January | 510.50 | 122.17 | 190.30 | 822.97 | ....... | 86.28 | 103.75 | ....... | 190.03 | 1,013.00 |
| February | 700.00 | 3.00 | 7.75 | 710.75 | ....... | 219.50 | ........ | ....... | 219.50 | 930.25 |
| March | 600.00 | ....... | 24.38 | 624.38 | ....... | 5.95 | 15.00 | ....... | 20.95 | 645.33 |
| April | 700.00 | 89.55 | 23.15 | 812.70 | ....... | 34.20 | 1.25 | $36.00 | 71.45 | 884.15 |
| May | 500.00 | ....... | ........ | 500.00 | $75.50 | 11.13 | 52.87 | ....... | 139.50 | 639.50 |
| June | 1,237.66 | 7.65 | 23.39 | 1,268.70 | 486.55 | 478.25 | 1.00 | ....... | 965.80 | 2,234.50 |
| Total | 8,070.07 | 461.50 | 1,089.67 | 9,621.24 | 562.05 | 953.46 | 1,328.50 | 36.00 | 2,880.01 | 12,501.25 |

*Commercial report for calendar year ending December 31, 1892.*

| Vessels. | Ascending. | | | | Descending. | | | | Total freight. |
|---|---|---|---|---|---|---|---|---|---|
| | Through lock. | | Through pass. | | Through lock. | | Through pass. | | |
| | *No.* | *Tons.* | *No.* | *Tons.* | *No.* | *Tons.* | *No.* | *Tons.* | *Tons.* |
| Packets | 75 | 4,740 | 381 | 42,365 | 74 | 3,983 | 373 | 36,218 | 87,306 |
| Towboats | 261 | .......... | 1,311 | .......... | 247 | .......... | 1,309 | .......... | .......... |
| Model barges | 2 | .......... | 83 | .......... | 2 | .......... | 79 | 61,800 | 61,800 |
| Coal boats | 92 | .......... | 515 | .......... | 1 | .......... | 1,069 | 976,599 | 976,599 |
| Barges | 490 | 2,557 | 3,092 | 26,324 | 36 | 7,252 | 3,454 | 1,747,600 | 1,783,733 |
| Flats | 370 | 1,658 | 1,081 | 17,360 | 301 | 18,340 | 1,472 | 278,296 | 315,654 |
| Rafts | ...... | .......... | 2 | .......... | 23 | 8,433 | 60 | 210,395 | 218,828 |
| Miscellaneous | 32 | .......... | 80 | .......... | 48 | .......... | 97 | .......... | .......... |
| Total | 1,322 | 8,955 | 6,545 | 86,049 | 732 | 38,008 | 7,913 | 3,310,908 | 3,443,920 |

## F F 4.

## MOVABLE DAM IN OHIO RIVER, BELOW MOUTH OF BEAVER RIVER, PENNSYLVANIA.

The first appropriation for the work was made September 19, 1890 ($250,000), and by the river and harbor act of July 13, 1892, an additional amount of $100,000 was appropriated.

This dam, which is located 30 miles below Pittsburg, Pa., will be the sixth in the series of movable dams for improving the Ohio River by slack-water navigation. Davis Island Dam, located 5½ miles below Pittsburg, and which has been in successful operation since October, 1885, is the first of the series. The land necessary for the site of this dam on both sides of the river was acquired, drawings prepared, and the preparatory work begun during the fiscal year ending June 30, 1892. During the fiscal year ending June 30, 1893, the temporary buildings required during the construction of the work have been erected and the working plant purchased and put into operation. The cofferdam for the lock was completed November 11, 1892, inclosing 6.3 acres. The permanent foundations for boiler house were completed and the drift chute for lock was finished for a length of 292 feet. The excavation for foundation of river wall of lock was commenced October 7, 1892, the material removed being used for filling the cofferdam. The ice during the winter of 1892-'93 caused some damage to the cofferdam and protection cribs. They were not materially injured, however.

This work has been under the immediate supervision of Mr. William Martin, assistant engineer.

### OPERATIONS DURING FISCAL YEAR.

[Extract from the report of Mr. William Martin.]

At the beginning of the fiscal year, July 1, 1892, a small force of men were engaged clearing the bank of the river of brush, willows, etc., and gathering rubble stone for protection cribs.

The construction of the temporary buildings—*i. e.*, office, blacksmith and carpenter shops, mess house, and cement shed—was commenced early in July, and they were soon ready for use. Later a temporary boiler house was built. The total cost of these buildings, labor and material included, was $5,222.

The construction of cribs for protection of cofferdam was commenced on the 25th of July, 1892. Two cribs, 20 feet square, and 14 cribs, 15 feet square, with a height varying from 7 to 18 feet, were built and filled with rubble stone at a total cost, labor included, of $3,250.64.

These cribs served well the purpose for which they were built and protected the cofferdam throughout the winter, which was the severest experienced in this locality for many years; but, while the cofferdam suffered little damage, 7 of the 14 cribs were knocked almost to pieces and will have to be rebuilt, and 4 others will require considerable repairing.

The Cleveland and Pittsburg Railroad Company established a station at the site of the dam and named it "Merrill," in honor of the memory of the late Lieut. Col. W. E. Merrill, Corps of Engineers.

A 12-car railroad siding was built here for the accommodation of the work.

On September 16, 1892, the construction of the cofferdam inclosing the site of the lock was commenced, and although considerable delay was caused by the nonarrival of the necessary material, the cofferdam was finished on November 11, 1892.

The total length of the cofferdam is 1,531 feet; average height, 14 feet; between walls, 12 feet; 250,000 feet, B. M., of lumber and 900 tie rods were used in its construction; 9,800 cubic yards of earth were required to fill in between the walls; of this, 2,240 cubic yards were placed by hand. This enabled us to pump out the cofferdam and the remainder of the filling, 7,560 cubic yards, was placed by the traveling derrick.

The total cost of the cofferdam was $12,327.88, divided as follows:

| | |
|---|---|
| Lumber | $2,654.30 |
| Tie rods, washers, nails, etc | 1,754.70 |
| Labor | 7,918.88 |
| | 12,327.88 |

Cost per linear foot, $8.05.

The cofferdam was not seriously injured during the winter. About 40 feet of the upper shore arm next to the bank was filled with sandy loam taken from the bank adjacent; the water washed this out, and the walls of the cofferdam collapsed.

The gravel taken from the excavation for the lock wall by the traveling crane and dumped into the cofferdam as filling was not affected by the high water.

To supply steam for the pumping, hoisting, and pile-driving engines, and for other uses in connection with construction, two 100-horse-power water-tube steam boilers were erected on a foundation which is designed to be permanent for use on the completed work.

From the boilers steam is conducted to the various engines. We find the plan of having a central permanent boiler preferable to a number of temporary ones, as the frequent settings and conveyance of fuel is more expensive. But one of the boilers is required at one time, except when pumping out the cofferdam inclosure after a flood, when both are used.

The cofferdam inclosure, containing 6.30 acres, was unwatered by two centrifugal pumps, a 10-inch and a 12-inch, inclosed in a crib sunk to a reference of 638 feet, being 17.90 feet below the sill of the lock. The discharge pipe was placed through the cofferdam at a reference of 666.60, making the lift 28.60 feet, being 5.60 less than if discharged over the top of the cofferdam, thus saving considerable work in making the increased lift. Both pumps were driven by a 14 by 16 inch engine.

The steam supply is furnished from a 100-horse-power water-tube boiler located on its permanent foundation, conveying the steam around the cofferdam a distance of 1,157 feet. The loss of steam pressure in conveying the steam the distance stated, with the pipe exposed, is only 10 per cent.

The foundation of the boiler house was commenced September 5, 1892, and finished December 3, 1892; 171 cubic yards of excavation had to be made for this foundation. It contains 54 cubic yards of brick masonry and 548 cubic yards of stone masonry, and cost $2,564.44. On this foundation the two boilers referred to were placed, and over this a temporary frame building was erected.

The high water of the past winter covered the floor of the boiler house to a depth of 6 feet; the flood of 1884 would have covered it to a depth of 18 feet.

The drift chute for the lock was commenced and finished to a distance of 292 feet; this required 602 cubic yards of excavation, 144 cubic yards stone masonry, and 234 cubic yards of brick masonry, and cost $3,823.88.

To make some yard room for the special stonecutting, earth was procured from the north side of the C. and P. R. R. tracks and dumped around and about the foundation of the boiler house; 8,952 cubic yards were thus delivered at a cost of $3,057,26.

The excavation for the foundation of the river wall of the lock was commenced on October 7, 1892. As reported in the last annual report, no rock was encountered at a depth of 14 feet below the proposed sill of the lock. Under these conditions it was designed to construct a foundation of concrete from the reference of 642 to 654, a height of 12 feet. Below the concrete a line of oak sheet piling, 6 by 12 inches by 10 feet, is to be driven to a depth of 9 feet, thus making a depth of foundation below the sill of the lock of 22.9 feet, for cutting off the leakage below the wall. This excavation was made with the assistance of the traveling crane, at a period when the river was at a very low stage. The crane operated on a track parallel with the wall, hoisting the excavated material (gravel) and dumping it in the framework of the cofferdam, thus making the excavation of the lock wall and puddling the cofferdam at one operation, the gravel from the excavation making the very best material for puddling.

After the cofferdam was filled, the gravel was piled on the bank, ready for use in making concrete. The excavation was completed, shoring finished, stone crusher and concrete mixer in place, and all was ready to commence making and laying concrete, when, on December 31, 1892, the winter set in in earnest and all outdoor work had to be abandoned.

Early in April, the weather being fine and the river low, the pumps were placed in position and started on the 6th, but rain and high water compelled us to stop on the 10th. This four days' pumping enabled us to unwater the cofferdam and proved that it was practically uninjured. During April and May the pumps were set up five times, and four times the high water and rain compelled us to remove them; since May 28 the pumps have been run steadily.

The concrete mixer, which was carried away during the winter in the ice, was found in the river about 100 miles below. It was returned and placed in position.

The cofferdam has been repaired; the protecting cribs are being repaired; the track for the traveling derrick, which was twisted out of place by the high water, has been relaid; the excavation for the foundation of the lock wall cleaned out; 628.1 cubic yards of concrete were laid in the foundation of the lock wall; 39 piles for the protection of the foundation of the wall have been driven. We find great difficulty in driving these piles; the gravel through which they have to be driven is compact and full of bowlders.

Owing to a slide of the bank during the high water about 50 feet of the drift chute was caved in; this has been repaired and work on the extension of the drift chute below the boiler house has progressed during June as follows: 961 cubic yards of excavation made; 17.8 cubic yards of concrete laid; 10.6 cubic yards brick masonry built.

No information has been received of the occupancy or injury of any United States pier, breakwater, lock, or dam by any individual or corporation, nor have I heard of any new bridges or structures being erected over or in the navigable waters near this work.

For commercial statistics please see those accompanying my report on operating and care of Davis Island.

A survey for the location of Lock and Dam No. 2 was made, and a report with map forwarded on February 16, 1893.

The contractors for furnishing stone, Messrs. Wilson Bros. & Co., of Ellwood, Pa., whose contract is dated November 21, 1892, began work early after receiving the award in erecting their plant and making preparations for carrying out their contract. To facilitate handling the broken stone, both at the quarries and at the place of delivery, I had the contractor erect his stone-crusher on the foundation of our boiler house in such a situation that the rubblestone can be delivered from the railroad by a small car, dumping its contents direct into the crusher; from thence the broken stone drops into a bin from which it is drawn by gravity to charge the concrete mixer. At the close of this report there has been gotten out at the quarries 1,200 cubic yards of stone cut and 250 cubic yards of special stone in the rough ready for delivery, and 666 cubic yards of broken stone for concrete-making, delivered.

## *Money statement.*

| | | |
|---|---|---|
| July 1, 1892, balance unexpended | | $243, 254. 76 |
| Amount appropriated by act approved July 13, 1892 | | 100, 000. 00 |
| | | 343, 254. 76 |
| June 30, 1893, amount expended during fiscal year | | 90, 404. 31 |
| July 1, 1893, balance unexpended | | 252, 850. 45 |
| July 1, 1893, outstanding liabilities | $9, 225. 19 | |
| July 1, 1893, amount covered by uncompleted contracts | 74, 022. 25 | |
| | | 83, 247. 44 |
| July 1, 1893, balance available | | 169, 603. 01 |
| Amount (estimated) required for completion of existing project (Lock and Dam No. 6.) | | 550, 000. 00 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895 | | 200, 000. 00 |
| Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893. | | |

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*Abstract of proposals for furnishing cement, lumber, tie rods, and washers for Lock and Movable Dam No. 6, Ohio River, received in response to advertisement dated July 11, 1892, and opened August 1, 1892, by Maj. Amos Stickney, Corps of Engineers.*

[Quantities, more or less].

| No. | Name of bidder. | Cement. | | | Lumber. | | | Iron. | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Price per barrel (17,000 barrels). | Price per barrel (8,500 barrels). | Amount of bid. | Price per feet B. M. (251,517 feet B. M.) hemlock. | Price per feet B. M. (5,000 feet B. M.) oak. | Amount of bid. | Price per pound (41,632 pounds) tie rods. | Price per pound (6,305 pounds) cast-iron washers. | Amount of bid. |
| 1 | S. M. Hamilton & Co. | $1.35 | | $22,950 | | | | | | |
| | | | $1.40 | 11,900 | | | | | | |
| 2 | J. C. Parsons | | | | $10.48 | | *$2,635.90 | | | |
| | | | | | | $21.00 | *105.00 | | | |
| 3 | Henry K. Gustin | | | | 18.10 | | 4,552.46 | | | |
| 4 | Beaver Falls Plaining Mill Co., limited. | | | | 12.25 | | 3,081.08 | | | |
| | | | | | | 20.00 | 100.00 | | | |
| 5 | Thompson C. Gill & Co. | | | | | | | $0.03$\frac{15}{100}$ | | *$1,311.41 |
| 6 | Excelsior Iron Roofing Co | | | | | | | .04½ | | 1,873.44 |
| | | | | | | | | | $0.04½ | *283.72 |

* Recommended for acceptance.

NOTE.—All proposals more or less informal.

All the above bids were rejected in consequence of regulations requiring that the provisions of the eight-hour law should form a part of all proposals. As the necessities of the work would not admit of readvertisement, the supplies named were purchased in open market under authority of the Chief of Engineers.

*Abstract of proposals for furnishing brick, sand, and stone for Lock and Movable Dam No. 6, Ohio River, received in response to advertisement dated August 26, 1892, and opened September 9, 1892, by Maj. Amos Stickney, Corps of Engineers.*

[Quantities, more or less.]

| No. | Name of bidder. | Brick. Price per M (184,000) for arches. | Brick. Price per M (117,000) for paving. | Brick. Amount of bid. | Sand. Price per cubic yard (3,000 cubic yards). | Sand. Amount of bid. |
|---|---|---|---|---|---|---|
| 1 | Simon Harrold | $9.50 | $11.50 | *3,093.50 | $1.95 | $5,850 |
| 2 | G. C. Wareham & Co | 10.00 | 11.75 | 3,214.75 | | |
| 7 | Shipman & Wendt | 15.00 | 18.00 | 4,866.00 | | |
| 8 | Iron City Sand Co | | | | .85 | *2,550 |

| No. | Name of bidder. | Stone. Price per cubic yard (10,000 cubic yards) broken. | Price per cubic yard (2,781 cubic yards) cut, dressed face. | Price per cubic yard (2,348 cubic yards) rough. | Price per cubic yard (3,800 cubic yards) rubble. | Price per ton (400 tons) small rubble. | Amount of bid. |
|---|---|---|---|---|---|---|---|
| 1 | Simon Harrold | $2.00 | $7.80 | $6.25 | $4.50 | $2.50 | $74,466.80 |
| 3 | G. C. Wareham & Co | 3.50 | 8.00 | 6.95 | 3.75 | 2.00 | 88,616.60 |
| 4 | James J. Davidson | 1.65 | 11.00 | 5.75 | 3.75 | 1.50 | 75,442.00 |
| 5 | Wilson Bros. & Co | 1.74 | 8.15 | 6.20 | 3.50 | 1.14 | *68,378.75 |
| 6 | Wm. B. Rodgers | 1.00 | 11.50 | 11.50 | 4.50 | 2.25 | 86,983.50 |
| 7 | Shipman & Wendt | 2.75 | 10.50 | 9.50 | 8.50 | 8.80 | 112,826.50 |
| 9 | F. Gwinner, jr | 2.00 | 9.50 | 7.75 | 4.75 | 2.50 | 83,666.50 |
| 10 | Consolidated Stone and Mining Co. | 2.34 | 17.30 | 9.70 | 4.60 | 1.70 | 112,446.90 |

* Recommended for acceptance.

*Abstract of contracts.*

| Contractor. | Articles. | Date of contract. | To expire. |
|---|---|---|---|
| Iron City Sand Co | Sand | Nov. 17, 1892 | Upon delivery of all the material. |
| Wilson Bros. & Co | Stone | Nov. 21, 1892 | |
| Simon Harrold | Brick | Nov. 24, 1892 | |

Commercial statistics are attached to the report for operating and care of Davis Island Dam, Ohio River.

## F F 5.

## IMPROVEMENT OF MONONGAHELA RIVER, WEST VIRGINIA AND PENNSYLVANIA.

*Statement of the amount and date of all appropriations.*

| | |
|---|---|
| June 10, 1872 | $25,000 |
| March 3, 1873 | 66,600 |
| June 23, 1874 | 25,000 |
| March 3, 1875 | 22,000 |
| June 18, 1878 | 25,000 |
| March 3, 1879 | 24,000 |
| June 14, 1880 | 25,000 |
| March 3, 1881 | 25,000 |
| August 2, 1882 | 25,000 |
| July 5, 1884 | 45,000 |
| August 5, 1886 | 90,900 |
| August 11, 1888 | 35,000 |
| September 25, 1889 (allotted from appropriation for examinations, surveys, and contingencies of rivers and harbors) | 4,000 |
| July 13, 1892 | 25,000 |
| Total | 461,900 |

The original project for the improvement of the Monongahela River was the construction of two locks and dams to continue slack-water navigation from the head of slack-water navigation of the Monongahela Navigation Company to Morgantown, W. Va., a distance of 14 miles. These locks and dams, known respectively as Nos. 8 and 9, were completed in 1889 and have been in successful operation.

The river and harbor act of July 13, 1892, appropriated the sum of $25,000 for the extension of the improvement on Monongahela River by beginning work on an additional lock and dam, which is designated as No. 10, and during the past fiscal year a survey has been made for the purpose of determining the exact location of this lock, which will be near Morgantown, W. Va.

This work has been under the immediate supervision of Mr. Philip Golay, assistant engineer.

### REPORT OF OPERATIONS FOR THE FISCAL YEAR.

[Extract from report of Mr. Philip Golay.]

Under the appropriation of July 13, 1892, containing an item of $25,000 for continuing the improvement of the Monongahela River, a survey was made with a view of locating Lock and Dam No. 10. The survey was very complete and accurate. It extended from the old Allender Mill Dam, three-quarters of a mile below Morgantown, to the head of Pool No. 9, covering about 3¼ miles of the river, and is represented by two maps showing soundings, adjacent improvements and farm lines, and depth of gravel over the rock in the bed of the river. The first map, dated April, 1893, represents the entire survey, and was necessarily drawn on a small scale. The second map, dated May, 1893, was drawn on a larger scale and represents the first mile of river above Morgantown, which includes the most favorable site for the proposed new lock and dam. This part of the river has a comparatively even rock bottom, covered, for the most part, with 2 or 3 feet of gravel. A location further upstream is impracticable because of a coal formation in the bed of the river. On the other hand the new lock and dam should be located above the Morgantown Suspension Bridge in order to leave all present space, about 45 feet, between the surface of the water and the bottom of the bridge. The coal dips toward Morgantown, at which place geologists claim the coal vein is 75 feet below the bed of the river. It is also important to select a location where there is sufficient rock over the coal vein to insure a safe foundation. The soundings show the present bed of the river, in the vicinity of the Morgantown Suspension Bridge, to be a little higher than the upper miter sill at Lock No. 9. The bed of the river at this place is gravel, and the channel can be deepened by dredging. If this be done there will be no difficulty in maintaining a channel throughout the entire length of the pool deeper than on the miter sills at each end of the pool.

A line of levels was very carefully run from the upper miter sill of Lock No. 9 to the head of Pool No. 9, and back again to check, agreeing to within one-quarter of an inch with observations of the water level taken under the most favorable circumstances, calm weather and very low water when there was no current in the pool.

It yet remains to do some boring to ascertain the nature and thickness of the rock bottom over the coal vein; to definitely locate the proposed lock and dam; survey, and obtain a title for, the necessary land on both sides of the river; erect a building to be used for an office and other purposes during the construction of the lock and dam, and afterwards as a dwelling for one of the lock-keepers. Such sum as may remain after the above expenditure can be used for preparatory work, procuring plant, etc.

The harbor of Pittsburg has been under the immediate supervision of of Mr. J. W. Arras, assistant engineer. The following is an extract from his report:

*Encroachments.*—During the past year little difficulty has been experienced on this river in maintaining an obedience to the law of 1890, prohibiting encroachments on the navigable channel. There were a few against whom for the first time complaints were made by navigators. All such cases were investigated, and, where there appeared to be sufficient ground for complaint, the proper legal action was taken.

The following is a list of those stopped from placing waste material into the stream either by injunction or agreement:

Oliver and Roberts Wire Company, limited, Pittsburg.
Dilworth, Porter & Co., Pittsburg.
Jones & Laughlin, Pittsburg.
Republic Iron Works, Pittsburg.
W. A. Scott & Son, Pittsburg.
Carnegie Steel Company, limited, Braddock, Pa.

In the case of John M. Clark, who, during the last fiscal year, was convicted of conducting a garbage dump at the Birmingham Bridge, in violation of the river and harbor act of September 19, 1890, the court refused a new trial and imposed a fine and costs of prosecution.

The United States grand jury indicted several parties charged with violating the act of 1890. They have not yet been tried.

*Bridges.*—Of the bridges authorized to be constructed across the Monongahela River during the year, work on only one, that at Elizabeth, 25 miles above Pittsburg, has been commenced.

Across the Youghiogheny River, the principal tributary of the Monongahela, and for a distance of 5 miles from its mouth, influenced by Dam No. 2 of the Monongahela Navigation Company's plant, two bridges, duly authorized were built. The bridge of the Portview Bridge Company is located at McKeesport, [illegible] mile above the mouth of the river. The Boston Bridge Company's bridge is located at Boston, Pa., about 3 miles above the mouth of the river. Both bridges have been constructed in accordance with the plans approved by the Secretary of War.

## *Money statement.*

| | |
|---|---:|
| July 1, 1892, balance unexpended | $358.48 |
| Amount appropriated by act approved July 13, 1892 | 25,000.00 |
| | 25,358.48 |
| June 30, 1893, amount expended during fiscal year | 1,759.99 |
| July 1, 1893, balance unexpended | 23,598.49 |
| July 1, 1893, outstanding liabilities | 251.94 |
| July 1, 1893, balance available | 23,346.55 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895<br>Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893. | 100,000.00 |

### COMMERCIAL STATISTICS.

*Commerce that passed through United States Lock No. 8 during 1892.*

| Month. | Ascending. | | Descending. | |
|---|---:|---:|---:|---:|
| | Passengers. | Freight. | Passengers. | Freight. |
| | | *Tons.* | | *Tons.* |
| January | 184 | 83.75 | 208 | 227.75 |
| February | 222 | 209.50 | 239 | 522.85 |
| March | 326 | 145.90 | 358 | 1,252.41 |
| April | 288 | 209.35 | 821 | 4,103.00 |
| May | 614 | 175.00 | 586 | 1,703.55 |
| June | 911 | 278.95 | 947 | 2,504.70 |
| July | 2,721 | 315.85 | 2,432 | 1,096.05 |
| August | 1,763 | 753.40 | 1,984 | 2,172.85 |
| September | 673 | 391.75 | 771 | 302.00 |
| October | 687 | 332.75 | 612 | 1,472.25 |
| November | 512 | 512.00 | 457 | 881.26 |
| December | 362 | 245.25 | 485 | 877.57 |
| Total | 9,263 | 3,653.45 | 9,400. | 17,116.24 |

*Commerce that passed through United States Lock No. 9 during 1892.*

| Month. | Ascending. | | Descending. | |
|---|---|---|---|---|
| | Passengers. | Freight. | Passengers. | Freight. |
| | | *Tons.* | | *Tons.* |
| uary | 209 | 154.55 | 182 | 24.85 |
| bruary | 260 | 648.25 | 234 | 82.50 |
| rch | 313 | 413.05 | 341 | 916.10 |
| ril | 309 | 578.70 | 283 | 3,150.45 |
| y | 530 | 1,052.95 | 465 | 674.60 |
| ne | 1,103 | 943.70 | 1,072 | 201.50 |
| ly | 2,453 | 1,099.75 | 1,912 | 537.75 |
| gust | 1,972 | 1,221.50 | 1,851 | 957.80 |
| tember | 653 | 1,088.75 | 741 | 93.75 |
| tober | 733 | 1,102.00 | 591 | 913.00 |
| vember | 517 | 1,319.85 | 438 | 1,056.75 |
| cember | 373 | 768.50 | 397 | 743.85 |
| Total | 9,425 | 10,391.55 | 8,507 | 10,252.00 |

Taking the average of the totals given in the above tables we find that the com-
erce during 1892 on the 14 miles of the Monongahela River, which is controlled by
e United States, is as follows:

| | |
|---|---|
| ns of freight | 20,707.07 |
| ssengers | 18,298 |

The following table, compiled from the annual reports of the Monongahela Navi-
tion Company, shows the commercial movement on the lower part of this river
r the past eight years:

| Articles. | 1885. | 1886. | 1887. | 1888. | 1889. | 1890. | 1891. | 1892. |
|---|---|---|---|---|---|---|---|---|
| | *Tons.* | *Tons.* | *Tons.* | *Tons.* | *Tons.* | *Tons.* | *Tons.* | *Tons.* |
| ick | 1,325 | 8,997 | 5,279 | 4,504 | 6,333 | 7,856 | 7,897 | 8,181 |
| ttle and horses | 374 | 386 | 501 | 585 | 729 | 648 | 783 | 647 |
| assified freight | 13,683 | 13,086 | 16,486 | 17,450 | 18,334 | 23,169 | 21,746 | 21,891 |
| al and coke | 3,265,078 | 4,297,768 | 2,998,690 | 4,400,996 | 3,084,175 | 4,486,322 | 4,291,874 | 3,884,162 |
| re clay | 8,463 | 3,296 | 2,383 | 3,476 | 5,982 | 5,021 | 6,193 | 4,720 |
| ogs | 138 | 83 | 259 | 379 | 266 | 340 | 302 | 107 |
| on: | | | | | | | | |
| Ore | 16,486 | 17,823 | 17,683 | 8,079 | 3,371 | 2,335 | ......... | ......... |
| In pigs | 11 | 5 | 7 | 10 | 15 | 5 | 3 | ......... |
| umber | 9,622 | 10,231 | 11,144 | 13,778 | 10,096 | 11,615 | 25,887 | 23,738 |
| l | 1,073 | ......... | 55 | ......... | ......... | ......... | ......... | ......... |
| pe | 595 | ......... | 2,285 | ......... | ......... | 2,394 | ......... | ......... |
| ats | 256 | 437 | 258 | 489 | 700 | 1,089 | 4,910 | ......... |
| sts, pit | 32,166 | 18,392 | 30,472 | 22,432 | 18,707 | 29,336 | 9,786 | 14,952 |
| ailroad ties | 135 | 161 | 30 | 555 | 3,165 | 232 | 160 | ......... |
| nd | 51,771 | 50,229 | 89,230 | 63,085 | 73,590 | 105,600 | 74,600 | 89,900 |
| eep | 134 | 108 | 233 | 193 | 164 | 60 | 112 | 123 |
| aves | 9 | 9 | ......... | 7 | 26 | 140 | 109 | 98 |
| eel rails | 22,428 | 45,795 | 57,490 | 10,688 | 32,177 | 34,609 | 11,422 | 29,391 |
| one | 7,612 | 4,621 | 910 | 3,636 | 9,580 | 811 | 4,595 | 2,120 |
| mber | 46,172 | 52,698 | 53,561 | 84,191 | 54,696 | 43,970 | 67,164 | 81,759 |
| hisky | 108 | 164 | 49 | 88 | 134 | 180 | 922 | 1,515 |
| ood | 230 | 196 | ......... | 184 | ......... | 58 | ......... | ......... |
| Total | 3,472,959 | 4,533,484 | 3,287,005 | 4,634,785 | 3,322,239 | 4,755,790 | 4,528,465 | 4,163,304 |
| ssengers | 24,698 | 26,885 | 50,584 | 44,714 | 45,811 | 31,828 | 48,744 | 80,590 |

*Coal tipples constructed along the Monongahela River during the fiscal years ending Jun 30, 1892 and 1893.*

| Name. | Side of river. | No. of pool. | Above Pittsburg. | Owner, post-office address, etc |
|---|---|---|---|---|
| 1892. | | | | |
| | | | *Miles.* | |
| Bowman Works | West | Fourth | 57 | A. G. Leonard, Brownsville, Pa. |
| Crescent Coal Co | West | Fourth | 54 | Roscoe, Washington County, Pa. |
| California Coal Co | West | Fourth | 52 | California, Pa. |
| Vesta Coal Co | West | Fourth | 45 | Jones & Laughlin, Pittsburg, Pa. |
| Blythe Coal Co | West | Fourth | 45 | Speers, Washington County, Pa. |
| Rostraver Coal Co | East | Fourth | 41 | J. Jones, Monongahela City, Pa. |
| Ella Coal Co | East | Third | 35 | Milesville, Allegheny County, Pa. |
| 1893. | | | | |
| Maxwell | East | Fifth | 63 | Maxwell & Carothers, Fredericktown, Pa. |
| H. B. Leonard | West | Fifth | 63 | Brownsville, Pa. |
| Shamokin Coal Co | East | Fourth | 53 | Do. |
| Mongah Coal Works | East | Third | 32 | Brown Bros., Pittsburg, Pa. |

These coal tipples constitute a very important part of the commercial equipment of the river, and while a few of them crowd somewhat upon the channel, yet they do not materially interfere with the navigation of the river.

*Increase in tonnage and number of passengers carried on the 14 miles of the Monongahela River, which is controlled by the United States, for the calendar year ending December 31, 1892.*

| Calendar year. | Tonnage. | Passengers |
|---|---|---|
| 1891 | 19,486.00 | 16,7[illegible] |
| 1892 | 20,707.07 | 18,[illegible] |
| Increase 1892 | 1,221.07 | 1,51[illegible] |

No new lines of transportation were established during the year.

## F F 6.

## OPERATING AND CARE OF LOCKS AND DAMS NOS. 8 AND 9, MONONGAHELA RIVER.

The Monongahela River, from Morgantown, W. Va., to its mouth at Pittsburg, is canalized by nine locks and dams, of which the first seven, counting from Pittsburg, are the property of the Monongahela Navigation Company, and the eighth and ninth are the property of the United States. The eighth dam is 88.15 miles above Pittsburg, and Morgantown, the head of the slackwater, is 102.16 miles from the same. It may therefore be stated that 14 miles of this river is under the direct control of the United States and 88 miles is under a private corporation.

The following is a statement of date and amount of all allotments for this work:

| | |
|---|---|
| August 5, 1884 | $1,000.00 |
| September 1, 1884 | 4,000.00 |
| November 3, 1884 | 4,500.00 |
| December 20, 1884 | 500.00 |
| June 1, 1885 | 100.00 |
| July 22, 1885 | 1,000.00 |
| July 15, 1886 | 1,200.00 |
| March 1, 1887 | 1,100.00 |
| July 1, 1887 | 11,000.00 |
| July 11, 1888 | 6,270.00 |
| October 27, 1888 | $3,000.00 |
| July 17, 1889 | 1,480.00 |
| October 7, 1889 | 1,500.00 |
| November 8, 1889 | 1,200.00 |
| July 24, 1890 | 12,300.00 |
| July 9, 1891 | 24,250.00 |
| July 21, 1892 | 34,017.86 |
| Total | 108,417.86 |

These locks have been successfully operated during the fiscal year ithout interruption to navigation, except by the ice which closed the ver from December 26, 1892, to February 2, 1893. The lower entrances o both locks have been dredged out and slight incidental repairs made o the locks and dams. Storage sheds were constructed at both locks, nd at No. 9 work was begun on two lock-keepers' dwellings. The banks elow No. 8 were partially protected by riprap. At No. 9 a portion f the apron to dam was repaired, a new step was constructed, and the op course of masonry at lock repaired.

This work has been under the immediate supervision of Mr. Philip olay, assistant engineer.

### REPORT OF OPERATIONS FOR THE FISCAL YEAR.

[Extract from report of Mr. Philip Golay.]

The river was closed by ice from December 26 to February 2. This was the only nterruption to navigation throughout the year.

On May 6 a naphtha launch arrived at Morgantown for use on the Upper Monon-ahela River. The machinery was found to be somewhat out of repair, but it has een thoroughly overhauled and righted up, and the boat is now rendering valuable ervice.

A cave has been constructed at each lock for the storage of naphtha in barrels.

### LOCK AND DAM NO. 8, MOUTH OF DUNKARD CREEK.

*Repairs, etc.*—The valves originally placed at the head of the turbine races had to e abandoned. They were made of wood and strapped with iron, and while not in se warped so that they could not be used when needed. Temporary wooden valves re now used as a makeshift. These will be replaced by metal valves which are al-eady on hand.

The necessary material and appliances have been procured for plastering the tur-ine races to prevent them from leaking, a condition not desirable, especially in reezing weather. The work will be done as soon as the new valves are placed and he stage of water will permit the drainage of the races.

Sheaves and wire rope were added to the operating machinery, so that both gates an be opened at the same time by the machinery on either wall at times when the achinery on the opposite wall can not be operated on account of breakage, repairs, r other causes.

Ever since the completion of the lock and dam at this place the bank below the lock has been gradually caving in and washing away. The break has extended in ome places beyond the boundary line of the United States land. Protection be-ame necessary and was commenced during the last fiscal year. For a distance of 274 feet down the river from lower end of guide crib, and near the edge of the water at normal pool level, a footing was made, *i. e.*, a trench was excavated to the depth of 4 feet and filled with broken stone. Along the entire length of this footing the slope above for a width of 10 feet was riprapped to the depth of 2 feet. Owing to a contemplated change of plan, the work was suspended at this point and nothing more was done beyond the delivery of riprap stone which had been previously engaged.

A new storage shed was constructed in place of the old one, which had become unfit for use. The building was placed at the upstream end of the lot, is a substan-tial frame structure, 20x46 feet, one story and a loft, set on solid stone walls, floors above high-water mark, covered with cedar shingles, and painted on the outside, including the roof.

The other buildings and the lock gates were also painted.

*Condition of the dam.*—In the fall of 1891 repairs were made on the dam; but on account of the late date at which the low-water season came, and its short duration, the repairs could not then be completed, and the work of replacing and bolting down the upper courses of sheeting and purlins beneath was postponed until a more favorable time. The comb of the dam was thus left, and still remains, elevated to such height as to cause pool No. 8, during low water, to stand about 1 foot above normal pool level. Upon recent careful examination no further injury or signs of weakness could be seen, and an immediate completion of the repairs is not con-sidered necessary.

*Dredging.*—A dredge, steamboat, and dump scows were hired from the Mon hela and Western Company of Pittsburg, Pa., to dredge out the accumulated ma rial in the approach below the lock. From October 25 to November 17, 4,450 cu yards of material, consisting of a deposit of gravel, sand, and loam, was dre from the channel immediately below the lock and dumped as close as possible ab the dam. The increased depth of water below the lock is a great advantage navigation; and the additional backing insures greater safety to the dam. The of the work was $2,177.64.

## LOCK AND DAM NO. 9, HOARDS ROCKS.

*Repairs on dam.*—The top course of masonry, temporarily repaired with timber 1892, was permanently repaired with concrete; and all open joints in the mas of the dam and abutment were repointed.

The sheeting of the original apron of the dam, for a distance of about 100 f next to the lock wall, was found to be much worn and in an open condition. A additional sheeting of 3-inch plank was placed upon this part of the apron.

A leak around the abutment was stopped by placing gravel and clay against t bank above.

*Step on apron of dam.*—A step 4 feet high and 13 feet wide was constructed on t crib apron of the dam. Material used in construction: 100,000 feet, B. M., oak tim ber; 400 cubic yards of stone filling, and 20,000 pounds of wrought-iron bolts. Co of the work, $3,954.30.

The following beneficial results were attained by the building of the step: Th additional weight helps to hold the apron down; increased strength to the dam; th fall of water from the crest of the dam is lessened and the horizontal velocity of th water, as it passes off of the apron, is diminished, thus having a mollifying effect the eddy below the lock.

*Sheathing guide wall and raising dam.*—The necessary material for sheathing th guide wall below the lock and for raising the dam to original height has been pu chased and delivered to the lock. The work of sheathing the guide wall is und way and the dam will be restored to original height as soon as the stage of wat will permit.

*Buildings.*—A contract for rebuilding lock-keepers' houses, carried away by the flood of 1888, was awarded in the month of April to J. M. Deffenbaugh of Mas town, Pa., and work on the contract has been commenced. The excavation for on cellar has been made and about half the stone for one foundation dressed an delivered to the lock.

A storage shed like the one recently built at Lock No. 8 was constructed on th upstream end of the United States land.

*Lock gates.*—The timber in the lock gates is much decayed and the gates ar thought to be unsafe. They should be rebuilt at an early day.

*Dredging.*—The Monongahela and Western Company's dredge and outfit wer employed to do some necessary dredging at this place. The channel below the loc was cleaned out and a spoilbank, made below the dam during the construction o the lock, was removed. The result was to cause more of the current to flow dow along the eastern shore and thereby destroy to some extent the troublesome edd below the lock. The material was dumped above the dam, where it serves to sto leaks that had made their appearance. Since this work has been done the entran of ascending steamers into the lock is much easier, but some trouble is yet exp enced at certain stages of the water in floating rafts out of the lock. Excavatio made September 16 to October 24 and November 18 to 23, 6,802 cubic yards. Co of the work, $3,631.88.

*Detailed statement of expenses incurred in operating and care of locks and dams on the Monongahela River during the fiscal year ending June 30, 1893.*

| Month. | Operating expenses. | | | | Repairs. | | | | Tools and appliances. | Grand total. |
|---|---|---|---|---|---|---|---|---|---|---|
| | Salaries. | Supplies. | Miscellaneous expenses. | Total. | Hire of boats and barges. | Labor. | Material. | Total. | | |
| **1892.** | | | | | | | | | | |
| July | | $16.50 | $80.80 | $97.80 | | | $274.73 | $274.73 | | $372.03 |
| August | $494.10 | | 280.50 | 774.60 | | | 41.67 | 41.67 | | 816.27 |
| September | 481.00 | | 111.10 | 592.10 | | | 2.10 | 2.10 | | 594.20 |
| October | 484.30 | | | 484.30 | | $712.01 | | 712.01 | | 1,196.31 |
| November | 475.00 | 26.55 | 874.00 | 875.55 | $1,171.60 | 876.48 | 1,645.61 | 3,693.69 | $12.75 | 4,581.99 |
| December | 566.92 | | 129.54 | 696.46 | 2,263.40 | 245.98 | 1,657.23 | 4,166.61 | 1.50 | 4,864.57 |
| **1893.** | | | | | | | | | | |
| January | 490.00 | 74.22 | 82.30 | 616.52 | 2,202.02 | 98.56 | 673.29 | 2,973.87 | 12.05 | 3,632.44 |
| February | 415.00 | | 5.33 | 420.33 | | | 106.47 | 106.47 | | 526.80 |
| March | 531.00 | 14.40 | 12.61 | 558.01 | | | | | 260.00 | 818.01 |
| April | 550.28 | 8.85 | 34.10 | 593.23 | | | | | | 593.23 |
| May | 490.00 | 44.48 | 95.00 | 629.48 | | 57.14 | 696.01 | 753.15 | .85 | 1,383.48 |
| June | 1,347.33 | 231.30 | 154.75 | 1,733.38 | | 1,151.81 | 5,894.33 | 7,046.14 | 12.00 | 8,791.52 |
| Total | 6,324.93 | 416.30 | 1,360.03 | 8,101.26 | 5,637.02 | 3,141.98 | 10,991.41 | 19,770.44 | 299.15 | 28,170.85 |

*Abstract of proposals for lock-keepers' dwellings at Lock No. 9, Monongahela River, received in response to advertisement dated February 17, 1893, and opened March 20, 1893, by Maj. Amos Stickney, Corps of Engineers.*

| No. | Name of bidder. | Two frame houses complete. |
|---|---|---|
| 1 | Blythe & Co | $7,225 |
| 2 | J. M. Deffenbaugh * | 6,500 |
| 3 | Elizabeth Planing Mill Co | 6,600 |
| 4 | Mundell, South & Keener | 7,500 |

* Recommended for acceptance.

*Abstract of contract.*

| Contractor. | Work. | Date of contract. | To expire. |
|---|---|---|---|
| J. M. Deffenbaugh | Building two lock-keepers' dwellings at Lock No. 9. | Apr. 10, 1893 | Sept. 19, 1893 |

Commercial statistics are attached to the report for the improvement of Monongahela River.

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## F F 7.

## PURCHASE OF LOCK AND DAM NO. 7, MONONGAHELA RIVER.

The case of the United States *vs.* The Monongahela Navigation Company, for the condemnation of this structure, was heard in the circuit court of the United States for the western district of Pennsylvania in November, 1890, and the value of the work was fixed at $209,000. The navigation company took an appeal to the Supreme Court of the United States, where the case was argued at the October term, 1892.

The judgment of the circuit court was reversed and case remanded with instructions to grant a new trial.

[Decision.—October term, 1892.—Statement of the case.—Monongahela Navigation Company v. United States.—Appeal from and error to the circuit court of the United States for the western district of Pennsylvania.—No. 722.—Argued October 25, 26, 1892.—Decided March 27, 1893.]

In the proceedings taken under the act of August 11, 1888 (25 Stat., pp. 400, 411, c. 860), to condemn Lock and Dam No. 7 of the Monongahela Navigation Company, that company is entitled, under the provisions of the fifth amendment to the Constitution, to recover compensation from the United States for the taking of the franchise to exact tolls, as well as for the value of the tangible property taken.

The assertion by Congress of its purpose to take the property which that company had constructed in the Monongahela River by authority of the State of Pennsylvania did not destroy the franchise granted to the company by the State. * * *

The judgment, therefore, will be reversed, and the case remanded with instructions to grant a new trial.

*Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $161,835.45 |
| July 1, 1893, balance unexpended | 161,835.45 |

## F F 8.

### PURCHASE OF LOCK AND DAM NO. 6, MONONGAHELA RIVER.

Under the act of Congress no steps can be taken towards the condemnation of this lock and dam until the United States has acquired title to Lock and Dam No. 7.

*Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $167,000.00 |
| July 1, 1893, balance unexpended | 167,000.00 |

## F F 9.

### IMPROVEMENT OF CHEAT RIVER, WEST VIRGINIA.

The river and harbor act of September 19, 1890, contained an appropriation of $13,000 for the improvement of Cheat River. This is the only appropriation ever made for this river.

The object of the improvement was to make the river navigable for loose logs, so as to bring out the immense supplies of timber found in the virgin forests on the Cheat River and its tributaries. In its natural condition it was impossible to bring down rafts, and a large percentage of the loose logs was stranded among the rocks and left there to decay.

The rough part of the river commences about 3 miles below Rowlesburg and terminates at Beaver Hole, 16 miles above the mouth, where the river emerges from Laurel Ridge. The total length of difficult river is 30 miles. The original project for the improvement of the river was the removal of such rock obstructions as interfered with the free passage of logs on a 6 or 8-foot stage of water. At the suggestion of lumbermen and others interested in the improvement of this river, an additional project was adopted of making a low-water channel from near Rowlesburg down the river, in which logs could be floated on a rise of from 2 to 3 feet. The improvement was completed so far as the funds available permitted in 1892, since which time no work has been done. The channel has been greatly improved and is now in fair condition between Rowlesburg and Green Island, a distance of 20¼ miles.

An additional sum could be advantageously expended in removing more rock from the channel. Between Pringle Run and Green Island 3,000 cubic yards of rock, mostly in the low-water channel, and between Green Island and Forge Island 7,000 cubic yards of rock could be thus removed. Guide cribs should also be constructed at the heads of some low bars to keep logs in the channel.

For the excavation of rock and construction of cribs the sum of $20,000 could be expended to advantage.

This work has been under the immediate supervision of Mr. Philip Golay, assistant engineer.

[Extract from report of Mr. Philip Golay.]

The boom built by Dewing & Sons, at "Shoo Fly Island," about 6 miles above the mouth of the river, was completed in full accordance with the plans approved by the Secretary of War.

The State Line Railroad Company have completed the piers of the railroad bridge at Point Marion, Pa., in full accordance with the plan approved by the Secretary of War; but have not yet put the superstructure in place.

### *Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $7.50 |
| July 1, 1893, balance unexpended | 7.50 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895 | 20,000.00 |
| Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867, and of sundry civil act of March 3, 1893. | |

---

*Timber product of Cheat River for year ending December 31, 1892.*

| Month. | Received by mills at mouth of river. | Passed on to points below. | Total. |
|---|---|---|---|
| | *Tons.* | *Tons.* | *Tons.* |
| January | 3,811.11 | 190.56 | 4,001.67 |
| February | 51.04 | 2.55 | 53.59 |
| March | 50.44 | 2.52 | 52.96 |
| April | 986.11 | 49.31 | 1,035.42 |
| May | 211.61 | 10.58 | 222.19 |
| June | 93.44 | 4.67 | 98.11 |
| July | 154.44 | 7.72 | 162.16 |
| August | 123,44 | 6.17 | 129.61 |
| September | 77.77 | 3.89 | 81.66 |
| October | 97.11 | 4.86 | 101.97 |
| November | 105.27 | 5.26 | 110.53 |
| December | 7,297.77 | 364.89 | 7,662.66 |
| Total | 13,059.55 | 652.98 | 13,712.53 |

*Timber product of Cheat River for twenty years ending December 31, 1892.*

| Date. | Received by mills at mouth of river. | Passed on to points below. | Total. | Date. | Received by mills at mouth of river. | Passed on to points below. | Total. |
|---|---|---|---|---|---|---|---|
| | *Tons.* | *Tons.* | *Tons.* | | *Tons.* | *Tons.* | *Tons.* |
| 1873 | 385.00 | 128.33 | 513.33 | 1883 | 916.67 | 305.56 | 1,222.23 |
| 1874 | 440.83 | 146.95 | 587.78 | 1884 | 540.83 | 180.28 | 721.11 |
| 1875 | 340.83 | 113.61 | 454.44 | 1885 | 5,540.83 | 1,846.94 | 7,387.77 |
| 1876 | 187.17 | 63.06 | 250.23 | 1886 | 4,527.50 | 1,509.17 | 6,036.67 |
| 1877 | 173.83 | 57.95 | 231.78 | 1887 | 6,035.83 | 2,011.94 | 8,047.77 |
| 1878 | 186.67 | 62.22 | 248.89 | 1888 | 3,612.50 | 1,204.17 | 4,816.67 |
| 1879 | 233.33 | 77.78 | 311.11 | 1889 | 5,625.00 | 1,875.00 | 7,500.00 |
| 1880 | 425.00 | 141.67 | 566.67 | 1890 | 3,741.17 | 1,247.06 | 4,988.23 |
| 1881 | 383.33 | 127.78 | 511.11 | 1891 | 13,310.10 | 665.51 | 13,975.61 |
| 1882 | 428.33 | 142.78 | 571.11 | 1892 | 13,059.55 | 652.98 | 13,712.53 |

## F F 10,

## IMPROVEMENT OF ALLEGHENY RIVER, PENNSYLVANIA.

The following is a statement of the amount and date of all appropriations for this river:

| | |
|---|---|
| March 3, 1879 | $10,000 |
| June 14, 1880 | 20,000 |
| March 3, 1881 | 25,000 |
| August 2, 1882 | 15,000 |
| July 5, 1884 | 35,000 |
| August 5, 1886 | 30,000 |
| August 11, 1888 | $25,000 |
| September 19, 1890 | 20,000 |
| July 13, 1892 | 25,000 |
| Total | 205,000 |

The original condition of the Allegheny as to depth, width, and navigability can not be stated in definite figures, as there is no defined plane from which to measure, both the low water and the elevation of the river bed being variable. The approved project for the improvement of the river is the removal of obstructions from the channel and the construction of low dams to close double channels, and of dikes to confine the waterway where the river is too wide. Much benefit to navigation has resulted. The late day when the appropriation of July 13, 1892, became available, rendered it inexpedient to begin much new work during the season. The work done during the year consisted in minor repairs to existing works and the removal of the bar in the channel at Pithole Ripple. The amount available will be expended during the coming season in building dikes and dams and removing obstructions.

This work has been under the immediate supervision of Mr. J. W. Arras, assistant engineer.

### OPERATIONS DURING THE FISCAL YEAR.

[Extract from report of Mr. J. W. Arras.]

In the river and harbor act of July 13, 1892, there was made an appropriation for continuing improvement of Alleghany River, Pennsylvania, of $25,000. At that time the matters first requiring attention were some miner repairs to existing works which had been slightly injured by ice during the previous winter, and the removal of the bar in the channel at Pithole Ripple, which was begun in 1891. After these works had been completed, and some examinations and a survey made with a view to determining on new improvements at other points, it was deemed too late in the season to commence the construction of extensive improvements.

### REPAIR, AND PRESENT CONDITION, OF EXISTING WORKS.

*Log chute at Corydon, Pa., 209 miles above Pittsburg.*—The damage sustained work during the previous winter was repaired. The section of raised sheeti taken up, the timbers and paving restored, and the sheeting again put dow new material was required. The cost of labor was $35.85.

During the past winter the milldam was again damaged by an ice gorge section of the sheet covering of the log chute raised. The repairs can be ma small cost.

*Dam at Cornplanter Islands, 204 miles above Pittsburg.*—This dam is in good tion.

*Dam at Hickory, 157 miles above Pittsburg.*—This dam is in good condition, that the abutment at the shore end has been damaged slightly by an ice gorg will require some attention.

*Dam at Pithole, 143 miles above Pittsburg.*—This dam is in as good condition a built.

*Dike at Red Bank, 64 miles above Pittsburg.*—The paving of the back slope, had been damaged by the heavy ice gorge of the previous winter, was restore original condition. The cost of the repairs was $56.25.

The ice of the past winter has caused some damage to the paving of the fron of this dike, and some repairs will be needed. It is estimated that the cost w exceed $40.

*Dam at Nicholsons Island, 37 miles above Pittsburg.*—Some displaced paving, by the washing out of some decayed ties, was restored at a trifling cost. Wi exception of about a square of paving which was scoured out during the pas ter, the dam is in good condition.

*Dam at Six Mile Island, 6 miles above Pittsburg.*—This structure seems to be i condition.

### REMOVAL OF OBSTRUCTIONS.

*Removal of bar at Pithole Ripple, 142 miles above Pittsburg.*—When work w pended in the fall of 1891, 500 cubic yards of rock had been removed from th Operations were resumed on August 20, 1892, and closed on October 11, 1892 bar was lowered to from 6 to 18 inches below the surface of low water. material was placed in the chute on the left. In all, 3240 cubic yards of bo and gravel were removed. The cost of labor on this work was $789.28.

In the removal of this bar there disappeared one of the most objectiona structions on the Allegheny River. Located, as it was, near the foot of a ver ripple, and directly in the path of the natural running channel, it compelle gators, in order to avoid being stranded on it, to follow closely the right sho order to do this with any degree of safety, it was necessary for them to annually, considerale time and some expense in the preparation of a passable nel along the shallow water and rocky bottom on that side. Now it is safe anywhere in the main channel chute.

### SURVEYS.

A survey and map were made of 2 miles of the river at Cowanshannock, miles above Pittsburg. The object of the survey was to assist in determining kind and location of a dike, or dikes, for the improvement of the troublesome at that place. Its cost was $126.81.

### ENCROACHMENTS.

The small number of complaints received from navigators during the past the best evidence that the vigorous action taken prior to the close of the las year, against parties encroaching on the river, has had the effect of causing a complete cessation of this unlawful practice. In all, eight complaints were re charging parties with violating the river and harbor act of 1890, but upon i gation it was found necessary to take legal steps in cases of only about one- these. In cases where injunctions were asked for by the United States attorn parties filed stipulations with the court agreeing to stop placing waste mat the stream pending the establishment of harbor lines. The United States jury also had an investigation made, and, including a number of persons w already ceased dumping material over the bank, it was able to indict only th parties. It is quite probable that after the establishment of harbor lines Government, little or no difficulty will be experienced from infractions of th

In addition to the improvements already made for the safety and relief of th gation of the Allegheny, the project for the expenditure of the money made av by the last river and harbor act contemplates the erection of a low dam mouth of Tionesta Creek, and of a dike or dikes at Cowanshannock, and the removal of rock and other obstructions from the channel between Tionesta and Pittsburg. Considerable work of this nature can yet be done with great advantage to navigation. The localities first deserving attention are Red Bank, where the present dike should be extended, and Tidioute, where one or more new dikes should be constructed. In my last report attention was called to the extension of slackwater navigation to at least 20 miles above Pittsburg, and I am still of the opinion that no more judicious expenditure could be made. The rapidly growing local trade on that portion (about 2 miles) of the lower Allegheny coming within the influence of the Davis Island Pool certainly seems to emphasize the necessity of such an improvement.

### *Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $1,622.15 |
| Amount appropriated by act approved July 13, 1892 | 25,000.00 |
| | 26,622.15 |
| June 30, 1893, amount expended during fiscal year | 3,564.69 |
| July 1, 1893, balance unexpended | 23,057.46 |
| July 1, 1893, outstanding liabilities | 150.00 |
| July 1, 1893, balance available | 22,907.46 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895 } Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893. | 25,000.00 |

COMMERCE.

Since there is no way of ascertaining the commerce of the Allegheny River except by corresponding with the various operators of the valley, this report is necessarily only approximate; and until a record of the trade is kept at some point it will be impossible to state whether there has or has not been an increase in the river's tonnage. The following statement of the principal commercial movements on the river during the calendar year 1892 is believed to be as complete as can at present be had:

| Articles. | Quantities. | Articles. | Quantities. |
|---|---|---|---|
| | *Tons.* | | *Tons.* |
| Barges | 4,860 | Lath | 575 |
| Bark | 3,215 | Manure | 8,335 |
| Barrels | 900 | Nitroglycerine | 1 |
| Boat bottoms | 28,656 | Piles | 4,113 |
| Brace poles | 688 | Pit posts | 5,437 |
| Cattle and horses | 286 | Rough lumber | 92,600 |
| Check posts | 1,205 | Sand | 64,000 |
| Coal | 195 | Shingles | 480 |
| Fire clay | 3,120 | Staves | 525 |
| Gas pipe | 450 | Stone | 18,579 |
| General freight | 1,928 | Timber | 104,013 |
| Gravel | 10,3 2 | | |
| Hay | 300 | Total | 354,[illegible] |

Passengers carried, 4,627.

In addition to the above, the following statement of the principal commercial movements in the Allegheny Harbor at Pittsburg is given:

| Articles. | Quantities. | Articles. | Quantities. |
|---|---|---|---|
| | *Tons.* | | *Tons.* |
| Brick | 400 | Manure | 16,790 |
| Cars, loaded | 415,449 | Railroad ties | 9,221 |
| Cars, empty | 98,424 | Sand | 103,282 |
| Coal | 246,632 | Staves | 638 |
| Gas pipe | 18,605 | Vegetables | 1,294 |
| General freight | 2,580 | | |
| Gravel | 35,450 | Total | 953,465 |
| Lumber | 4,700 | | |

Passengers carried, 27,000.

The timber and most of the lumber transported on the Allegheny River is rafted at headwaters and floated to its destination. The rafts vary in size from 50 feet by 400 feet above the Tionesta to 70 feet by 400 feet below it, and draw from 1.5 feet to 3 feet of water. The remaining portion of the lumber and nearly all other timber products, such as shingles, lath, poles, posts, bark, etc., are transported to down-river points in the boat bottoms which are manufactured in the Tionesta and Clarion valleys. About 800 of these bottoms are annually built and run out of the Allegheny. They are 26 feet by 176 feet and draw from 8 inches when empty to 16 to 20 inches when loaded. Their carrying capacity is 140 tons. There are also manufactured annually in the Tionesta Valley 90 coal barges, about one-half of the number annually required by the Pittsburg coal trade. All minerals and materials other than timber products are generally transported in guypers and flats drawing from 1.5 to 4 feet and having a carrying capacity of from 75 to 200 tons. These guypers and flats are usually towed by small boats. The steamboat *Nellie Hudson No. 3*, running in the packet trade between Pittsburg and Kittanning, a distance of 45 miles, has a tonnage of 200.

## F F 11.

## DAM AT HERR ISLAND, ALLEGHENY RIVER, NEAR PITTSBURG, PA.

The following is a statement of the amount and date of all appropriations for this work:

| | |
|---|---|
| August 5, 1886 | $37,500 |
| August 11, 1888 | 35,000 |
| September 19, 1890 | 35,000 |
| July 13, 1892 | 40,000 |
| Total | 147,500 |

The object of this dam is to begin a system of slackwater navigation on the Allegheny River and enlarge the harbor room at Pittsburg to the extent of the pool formed by the dam.

The original project was for a fixed dam, but in compliance with the request of the authorities of Pittsburg and Allegheny City the Secretary of War has ordered that the dam at Herr Island be made a movable one. This change in design necessitated a corresponding change in the estimated cost of the work. The estimate made by the late Lieut. Col. William E. Merrill was $600,000.

Much delay in commencing the work was caused by suits brought by the riparian owners, but by a change of location, so that the lock was placed out 55 feet from the bank to provide a passage way, the riparian owners were satisfied and their opposition was withdrawn. The land necessary for the lock and dam has been acquired and all legal questions as to damages to adjoining property settled. Observations of the current and water levels have been taken and borings made for the purpose of determining the character of the river bed. Preparations have been made and material obtained for the construction of the cofferdam for the lock, which will be built during the low water season.

This work has been under the immediate supervision of Mr. J. W. Arras, assistant engineer.

### OPERATIONS DURING THE FISCAL YEAR.

[Extract from report of Mr. J. W. Arras.]

At the close of the last fiscal year there was still pending in the circuit court of the United States the suit for damages to the property abutting on the site of the proposed lock. Evidence had been procured, and preparation made for the Government's defense, but late in the season of 1892 the case had not yet been given a hear-ing. At this discouraging state in the history of this much-delayed improvement a suggestion was made that the Government agree to construct its walls a sufficient distance from the bank of the river to permit the riparian owners back of them to use their landings, and that the latter withdraw their suit. This plan, in its tendency to end the litigation and thereby to remove all obstructions to the construction of the dam, seemed to meet with general favor, and the suggestion was immediately followed by a formal proposition by the plaintiffs in the suit, which has since been accepted by the Government.

The land necessary for the lock and dam having been acquired, and all legal questions as to damages on adjoining property settled, preparations were made to commence the work of constructing the lock. The material for the cofferdam for the lock, and for the cribs for its protection against ice and floods, has been engaged, and a part of it delivered at the site of the work. Operations on the construction of the cofferdam will begin at once, and, considering the season of year, rapid progress should be made on the work.

Some other preliminary work has also been done. Water gauges were erected and a record of their readings kept. Observations to determine the exact course of the current at the site of the dam were taken. Borings were made in the river bed on the line of the dam to determine the character of the foundation. The holes were drilled to the depth of 30 feet below the level of the Davis Island pool. Only clay, gravel, and sand were encountered. From reports of persons who have drilled deep wells in the vicinity of the lock, rock is found at about 45 feet below the Davis Island pool level.

The lot for lock buildings has also been cleared of the rubbish which has accumulated on it during the time it has not been in use.

### *Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $68,696.85 |
| Amount appropriated by act approved July 13, 1892 | 40,000.00 |
| | 108,696.85 |
| June 30, 1893, amount expended during fiscal year | 931.21 |
| July 1, 1893, balance unexpended | 107,765.64 |
| July 1, 1893, outstanding liabilities | 145.60 |
| July 1, 1893, balance available | 107,620.04 |
| Amount (estimated) required for completion of existing project | 484,500.00 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895 | 200,000.00 |
| Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry-civil act of March 3, 1893. | |

## F F 12.

## ICE HARBOR AT MOUTH OF MUSKINGUM RIVER, OHIO.

The following is a statement of the amount and date of all appropriations for the work:

| | | | |
|---|---|---|---|
| March 3, 1879 | $30,000 | August 5, 1886 | 37,500 |
| June 14, 1880 | 50,000 | August 11, 1888 | 60,000 |
| March 3, 1881 | 30,000 | September 19, 1890 | 30,000 |
| August 2, 1882 | 40,000 | | |
| July 5, 1884 | 50,000 | Total | 327,500 |

The ice harbor is the lower pool of the Muskingum River, which has been created by the slackwater dam at Marietta, and the object of the work under consideration is to build a passway through this dam, of such size as will permit Ohio River packets and coal fleets to take refuge from ice in this pool. The passway in question consists of a large lock, which, owing to the local conditions controlling the only available site, was built with independent axes of entrance and exit, pass the bridge by flanking over to the other side of the river and going through the old draw. I would recommend that the amount of $10,000 be appropriated, and if this is approved will place it in my estimate in annual report.

Very respectfully, your obedient servant,

AMOS STICKNEY,
*Lieut. Colonel of Engineers.*

Brig. Gen. THOMAS L. CASEY,
*Chief of Engineers, U. S. A.*

The question relating to the changing of the bridge belonging to the Baltimore and Ohio Southwestern Railroad Company should be settled in some way, in order that the lock might be entered by the Ohio River boats and the pool above utilized as an ice harbor, in accordance with the purpose for which the lock was built. The bridge as it now stands, crossing the Muskingum River just below the lock, has a draw on the side of the river opposite to the lock, the side where the old lock was located. The railroad company have declined to place a second draw in their bridge for passage into the new lock, arguing that it should be done by the United States, on account of the United States having changed the channel away from the side of the river where they had provided a draw. I would suggest that the matter might be settled by Congressional act authorizing the Secretary of War to have the bridge changed under an agreement with the railroad company and appropriating such amount as might be necessary to make the change, estimated by the late Col. Merrill at $30,000, with the proviso that the matter should be brought before the United States courts for a decision as to whether the change should be made at the expense of the United States or the railroad company, and in case it was decided that the cost should be borne by the railroad company said company should reimburse the United States for the money expended.

Commercial statistics are attached to the report for operating and care of locks and dams on the Muskingum River.

*Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $50.78 |
| June 30, 1893, amount expended during fiscal year | 10.10 |
| July 1, 1893, balance unexpended | 40.68 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895<br>Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893. | 10,000.00 |

## F F 13.

### IMPROVEMENT OF MUSKINGUM RIVER, OHIO.

### LOCKS AT ZANESVILLE AND TAYLORSVILLE.

A survey of the river was made, covering a distance of 4,400 feet between the head of the canal at Zanesville and a point 500 feet above the old lock, to obtain information as to the best plan for the reconstruction of the locks at that point. The lock at Taylorsville is now practically completed, with the exception of the machinery for operating the gates; but this lock can not be made available until a draw is placed in the county bridge, just below it. The commissioners of Muskingum County, to whom the bridge belongs, were ordered to it, but thus far have not done so.

With regard to the reconstruction of the lock at Zanesville has been held in abeyance for some time, I would say that Col. my predecessor in charge of this work, was undecided as to the lock should be reconstructed in its present location or at further up the river, which would permit the abandonment of th part of the canal.

In order to determine the advisability and practicability of the lock in a more favorable location, a survey of the locality h made. From the report of Mr. Moeser, Assistant Engineer, an of which is appended, it would appear probable that it would b to retain the present location. A plan for reconstruction of t will be presented after further study of the subject.

This work has been under the immediate supervision of Mr. E Moeser, Assistant Engineer.

### OPERATIONS FOR THE FISCAL YEAR.

[Extract from the report of Mr. Edmund Moeser.]

This work is carried on under the appropriation of August 11, 1888, for struction of a lock at Taylorsville and the reconstruction of the lock at Za Ohio.

At the beginning of the year the work yet to be done at the new Taylors was to build lower gates, complete lock ladders and gate-operating machi to build a guiding crib above the river wall. The lower gates were fini placed in position and lock ladders made. As the lock can not be used unt is placed in the Taylorsville and Duncans Falls bridge, it was thought un to make gate machines or build a crib above the lock until they are neede

Under that part of the appropriation relating to the reconstruction of th Zanesville, a complete survey was made in November and December, 189 point 500 feet below old lock No. 10 to the head of the canal at Zanesvil tance of 4,400 feet.

The following facts are developed by this survey:

(1) A lock built at any point above the site of the existing lock must be on piling.

(2) The foundations of the pivot and rest piers of the Sixth Street B built on timbers and are too high to permit of a lower pool channel betwe it would therefore be necessary, in case the lock is located at any point a bridge, to rebuild the pivot pier and at least one of the rest piers.

(3) The Taylorsville dam should be raised 2 feet in order to maintain a depth in lower approach to new lock.

(4) A part of the canal must undoubtedly be retained, as the dam is si the head of what is called the "Falls of the Muskingum;" the shortest canal around these falls would be 1,700 feet in length The length of th canal is 3,900 feet. In view of these facts, and for the reason that the pre is founded on rock and there would be no difficulty in rebuilding and makin class lock of it at a moderate expense, I would respectfully recommend tha taken to reconstruct the lock at its present location. The work necessa complish this is the suppression of one chamber in the combined lock, stone in upper walls to build buttresses and strengthen lower lock wall cylindrical valves at upper end and balanced valves at lower end of sin build new upper gates and rebuild lower gates. The estimated cost is $17,

The cost of building a new lock between the Sixth Street and Thi bridges is estimated at $85,000; this does not include cost of alterations t dredging channel below lock, or raising dam at Taylorsville.

Commercial statistics are attached to the report for operati care of locks and dams on Muskingum River.

### *Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $ |
| June 30, 1893, amount expended during fiscal year | |
| July 1, 1893, balance unexpended | |

## F F 14.

## OPERATING AND CARE OF LOCKS AND DAMS ON MUSKINGUM RIVER, OHIO.

The following is a statement of the amount and date of all appropriations and allotments for this work:

| | |
|---|---|
| August 5, 1886, appropriated | $20,000.00 |
| July 21, 1887, allotted | 190,000.00 |
| August 13, 1888, allotted | 177,623.00 |
| July 1, 1889, allotted | 232,080.00 |
| July 19, 1890, allotted | 195,665.00 |
| June 1, 1891, allotted | 20,000.00 |
| July 8, 1891, allotted | 155,200.00 |
| November 10, 1891, allotted | $39,980.00 |
| November 25, 1891, allotted | 1,200.00 |
| December 10, 1891, allotted | 1,200.00 |
| January 5, 1892, allotted | 12,241.54 |
| August 3, 1892, allotted | 42,919.47 |
| Total | 1,088,109.01 |

As originally improved by the State of Ohio, 11 dams and 12 locks were built on the Muskingum River, furnishing continuous navigation for 91 miles from the Ohio River at Marietta to Dresden, where a connection was made with the Ohio Canal near its middle point, this canal extending from the Ohio River at Portsmouth to Lake Erie at Cleveland. According to old reports from the State board of public works, the locks were built with a length between hollow quoins of 180 feet and a clear width of 36 feet, except the upper lock between Zanesville and Dresden, which had a length of 120 feet and a clear width of 22 feet. The lifts, as reported, varied from 8 feet 10 inches to 12 feet 1 inch, but measurements made since the United States took charge show that none of the above dimensions were strictly accurate. The work cost the State of Ohio about $1,500,000. The lock and dam above Zanesville is now in a state of ruin, but the 75 miles of slack water between the Ohio River and Zanesville have always been maintained; on this piece of river there are 10 dams, 11 locks, and 5 lateral canals, with a total length of 3⅔ miles.

The locks and dams were about worn out when they passed into the hands of the United States in April, 1887, and a general reconstruction was unavoidable. This work was very greatly retarded and cost of reconstruction much increased by the extraordinary rainfalls during the progress of the work in 1890. Again in 1893 the floods were even more numerous and excessive, the Muskingum and Licking rivers reaching a phenomenally high stage, and causing damage to embankments, canal banks, and some of the old dams. During the flood in May of this year about 70 feet of the old dam, No. 6, at Stockport, was carried away with a portion of the old abutment, and the embankment back of the abutment at dam No. 8 was only saved by prompt and energetic efforts. At a number of the dams on this river there are dangerous washes of the banks below the dams, and at each recurrence of flood stages much anxiety is felt with regard to the possibilities of the river going around the abutments. These banks should be protected to prevent great damage and costly repairs. The greatly improved condition of the river was fully demonstrated during the past low-water season, when a navigable depth of 6 feet was maintained. During the year there was entire suspension of navigation of only forty-five days, which was due to ice and submergence of locks during floods. All the repairs contemplated for the year were completed and incidental repairs made as required. This work has been under the immediate supervision of Mr. Edmund Moeser, assistant engineer.

### OPERATIONS DURING THE FISCAL YEAR.

[Extract from the report of Mr. Edmund Moeser.]

All work of repairs as proposed in the project for the year has been completed and such incidental work done as was necessary to maintain the navigable condition of the river. On account of the river being obstructed by ice, through navigation was suspended from December 24, 1892, to February 1, 1893; adding to this the number of days the locks were submerged by floods, there was an entire suspension of navigation for a period of forty-five days. The failure of a part of the old portion of Dam No. 6, Stockport, made the lock useless until a coffer could be placed around the break; work on the coffer was commenced May 20, but owing to frequent interruptions by high water it was not completed until the latter part of June.

The spring of 1893 was phenomenal for floods, and the high water did considerable damage to embankments, canal banks, and sheeting on old dams, all of which should be repaired before another winter.

During the protracted low-water season of 1892 the improved condition of the river since the United States assumed control was fully demonstrated by the fact that a 6-foot depth was available in the Muskingum, when all boats on the upper Ohio River were compelled to lay up on account of low water. At no time during the season were any of the dams out of water, a fact that speaks well for their tight condition.

The greatest obstruction to successful navigation on the Muskingum River is caused by the Baltimore and Ohio Southwestern Railroad bridge at Marietta, and the highway bridge over the river at Taylorsville. The delay and danger of making a crossing from the lock on the left side to the draw on the right side of the river at Marietta would be obviated if the present fixed channel span was replaced by a draw. Lock No. 1 would then be available to Ohio River craft, and the object for which it was built attained. The absence of a draw in the bridge just below the new lock at Taylorsville makes the lock useless; boats are therefore compelled to use the lateral canal at this place. The cost of maintaining more than a mile of canal and the delay in the time required for boats passing this place would be avoided if the desired draw was inserted.

### LOCKS AND DAMS.

*Lock and Dam No. 1, Marietta.*—The bottom of the mill race, back of the land wall of lock, was covered with a layer of gravel and paved for a distance of 70 feet with stone set in cement mortar. A face wall 35 feet in length was built below the head wall of race to retain earth bank, and a dry wall, 70 feet in length, was built to hold earth fill in area at lower end of lock, between wall and mill race. A leak in crib below lock was stopped by refilling crib with tight material. A number of piles were driven in the river above the railroad bridge for the protection of boats compelled to cross between dam and bridge, from lock on left side to draw on right side of river. The piling obstructing lower approach to lock were cut off at bed of river with dynamite. The dam was backed with gravel taken from pool above dam and with stone taken from old coffers at lock. This lock was built under appropriations for Muskingum ice harbor lock, and though incomplete, owing to inadequate appropriations, it has been successfully operated during the past year in connection with the system of locks on the Muskingum River. Capstans for temporary use in operating the gates were placed on the walls.

*Lock and Dam No. 2, Devols.*—At the beginning of the fiscal year the lock was open to navigation, although the repairs were not completed. During the year 220 feet of the lock walls were raised 3 feet, a guiding crib 60 feet in length was built below the lock, and the lockkeeper's house was thoroughly repaired and placed in a habitable condition. This work was completed December 1, 1892; ladders, well plates, check posts, and machines for operating the gates were then made and placed on the lock walls. To entirely complete repairs to this lock, there remains 50 feet of coping to dress back flush with chamber face of lock, and a small amount of concreting on old walls to stop leaks; other repairs necessary at this place are resheeting 25 feet of top of dam, replacing part of crib extension to right abutment, and minor repairs to embankment back of abutment.

*Lock and Dam No. 3, Lowell.*—With the exception of guiding piles placed above and below the two bridges over the canal, the work at this place was limited to some minor details in connection with the lock, and incidental repairs to canal bank. Cover plates, gate-operating machinery, lock ladders, and wrought-iron check posts were made and placed on lock walls. No repairs were made to the dam, as nothing was necessary.

*Lock and Dam No. 4, Beverly.*—Guiding piles were driven above and below bridge over canal. The canal bank at head of lock was refilled to a level with the top of the lock, and planted in grass. An earth fill was made back of guard-gate abutment at head of canal, to prevent the river from cutting around the gates. Small repairs were made to paving on embankment at right abutment.

Check posts, lock ladders, and machines for operating gates were made for the lock. The dam is in good condition and, with the exception of a small amount of backing placed at the right end, no repairs were necessary.

The following work remains to be done at this place: Rebuilding guiding crib below river wall of lock; rebuilding a retaining wall at head of canal, which failed during the winter floods; resheeting spill dam at head of canal, the sheeting being decayed and worthless, and making repairs to extension and embankment at right abutment.

*Lock and Dam No. 5, Luke Chute.*—The lock was open to navigation May 6, 1892; at that time the repairs were not complete, as 310 feet of the lower end of the walls remained to be raised to standard guard; the 3 feet of height required were laid with rubble concrete, the top and sides being finished with a thin layer made with one part best Portland cement to one part sand. This work has been perfectly satisfactory, and, as compared with other coping laid on Muskingum River, the cost was about one-half.

The work of completing the walls was resumed August 25 and completed in September. Machines for operating gates, check posts, and six new levers for operating slide valves on lower gates were made. The repairs to dam were completed by sheeting the slope for a distance of 72 feet; low places in the crest of dam were raised to a uniform level, and all empty cribs filled with stone. The paving on the downstream slope of embankment at left abutment, which had failed, was rebuilt for a distance of 40 feet. The project for next season is to repair damage done by recent floods, as rebuilding part of guiding crib at head of lock and embankment at abutment, and to rebuild an old guiding crib below lock; to finish concreting and pointing old lock walls, and to complete terreplein of lock.

*Lock and Dam No. 6, Stockport.*—With the exception of the making of well plates, check posts, and lock ladders, no work was done on the lock, which is in first-class condition. The lockkeeper's house, which was entirely worthless, was extensively repaired.

During the month of May, a section of old dam next the abutment, 70 feet in length, was destroyed, and the superstructure of the old abutment was so badly damaged at a point about 2 feet below the comb of dam that the top of the abutment fell into the river a few days after the dam went out. Prompt measures were at once taken to place a brush coffer around the break, but continued rains and high water delayed the work so that the coffer was not completed until the close of June.

The proposed work for this season is to grade area back of lock wall, and to rebuild abutment and about 90 feet of dam.

*Lock and Dam No. 7, McConnelsville.*—Guiding piles were driven above and below the bridge over canal. The Government bridge over canal was made serviceable by making a new turntable, renewing the floor of bridge, and rebuilding approaches.

Operating machines, cover plates, check posts, and lock ladders were made for the lock.

A section of the dam, 40 feet in length, was rebuilt, and new sheeting placed on the lower apron for a distance of 108 feet. All cavities in dam were refilled with stone.

In the boat and store yard two new center dumping scows, for use with the Muskingum River dredge, were built. The principal features of these scows are proper ventilation alongside of the bins, a pair of vertical trusses extending full length in the hold of each scow, and, in place of the usual dumping shaft, a box girder of sufficient strength to carry the load, and inclosing the apparatus for operating doors.

*Lock and Dam No. 8, Eagleport.*—A leak through the river wall was stopped by backing river side of wall from dam to head of lock with gravel and stone. Cover plates, lock ladders, and iron check posts were made for the lock. No work on the dam was necessary. From observations taken during the past year the advantage of the slope dam, at this place, over the former step was shown. The new slope was built in 1891, and the effect has been to cause a deposit at the foot of the dam along its entire front, adding greatly to its stability. The continued high water that prevailed during the past winter and spring was disastrous to the embankment back of the right abutment and terreplein of the lock; the downstream slope of the embankment at abutment failed, and a breech in the embankment was only averted by hard and persevering work.

The work to be done at this place during the present season is, repairs to embankment, terreplein and lock, rebuilding guiding crib at head of lock, and part of cross crib at lower end of lock, and repairing the lockkeeper's house, which is in a dilapidated condition.

*Muskingum River leases for year ending April 30, 1893.*

| Location. | Lessee. | Dated. | Expires. |
|---|---|---|---|
| Dam No. 1, Marietta | Phœnix Mill Co | May 1, 1873 | May 1, 1903 |
| Dam No. 2, Devols | Gates & Payne | May 1, 1889 | May 1, 1909 |
| Dam No. 3, Lowell | Milton King | ...do | Nov. 1, 1909 |
| Do | F. Wilking & Co | May 1, 1890 | May 1, 1910 |
| Do | Rechsteiner Bros | ...do | Do. |
| Do | ...do | Nov. 1, 1892 | Nov. 1, 1912 |
| Do | E. W. Sprague | Dec. 2, 1879 | Dec. 15, 1909 |
| Do | George Rice | Sept. 1, 1889 | Sept. 1, 1909 |
| Dam No. 4, Beverly | Robbins Bros | May 1, 1889 | May 1, 1909 |
| Do | Stull & Jumper | May 3, 1889 | May 3, 1909 |
| Do | George S. Worstell | May 1, 1890 | May 1, 1910 |
| Do | Mary L. Baldwin | ...do | Do. |
| Do | D. T. Brown | ...do | Do. |
| Do | Isaac D. Spooner | ...do | Do. |
| Dam No. 6, Stockport | Joseph Newberry | May 1, 1889 | May 1, 1909 |
| Dam No. 7, McConnelsville | E. M. Stanberry | Sept., 1839 | |
| Dam No. 9, Duncans Falls | John Miller | Dec. 31, 1836 | |
| Dam No. 9, Taylorsville | Frazier & Son | ...do | |
| Dam No. 10, Zanesville | John T. Drone | May 1, 1890 | May 1, 1910 |
| Do | Edward Johnson | ...do | Do. |
| Do | ...do | May 1, 1889 | May 1, 1909 |
| Do | Muskingum Coffin Co | May 1, 1890 | May 1, 1910 |
| Do | Gary & McLaughlin | ...do | Do. |
| Do | Beaumont & Blankenbuhler | July 1, 1889 | July 1, 1909 |
| Symmes Creek | Sarah V. Plummer | April 2, 1889 | Apr. 2, 1894 |

*Muskingum River leases for year ending May 31, 1893.*

| Location. | Lessee. | Dated. | Expires. |
|---|---|---|---|
| Dam No. 10, Zanesville | John Blankenbuhler | June 1, 1892 | June 1, 1909 |
| Do | Wm. F. Beaumont | ...do | Do. |
| Do | Frederick Abel | ...do | Do. |

| Lessee. | Subject. | cubic feet of water per min. | Annual rental. | Rebate. | Rents collected. |
|---|---|---|---|---|---|
| Phœnix Mill Co | Water power | 3,000 | $350.00 | $164.39 | $185.61 |
| Gates & Payne | ...do | 9,000 | 108.00 | | 108.00 |
| Milton King[*] | ...do | 2,600 | 100.00 | | |
| F. Wilking & Co | ...do | 7,280 | 174.72 | | 174.72 |
| Rechsteiner Bros | ...do | 4,446 | 106.70 | | 106.70 |
| Do | Land | | 10.00 | | 5.00 |
| E. W. Sprague | ...do | | 5.00 | | 5.00 |
| George Rice | ...do | | 6.00 | | 6.00 |
| Robbins Bros | Water power | 1,904 | 100.00 | | 100.00 |
| Stull & Jumper | ...do | 5,500 | 132.00 | | 132.00 |
| George S. Worstell | ...do | 5,600 | 114.24 | | 114.24 |
| Mary L. Baldwin | ...do | 5,000 | 100.00 | | 100.00 |
| D. T. Brown | ...do | 6,500 | 118.30 | | 118.30 |
| Isaac D. Spooner | ...do | 4,000 | 100.00 | | 100.00 |
| Joseph Newberry | ...do | 6,390 | 230.04 | | 230.04 |
| E. M. Stanberry[†] | ...do | (‡) | | | |
| John Miller[†] | ...do | (§) | | | |
| Frazier & Son[†] | ...do | (§) | | | |
| John T. Drone | ...do | 7,560 | 453.60 | | 453.60 |
| Edward Johnson | ...do | 6,029 | 361.74 | | 361.74 |
| Do | ...do | 7,399 | 443.82 | | 443.82 |
| Muskingum Coffin Co | ...do | 4,619 | 207.86 | | 207.86 |
| Gary & McLaughlin | ...do | 4,619 | 186.97 | | 186.96 |
| Beaumont & Blankenbuhler[‖] | ...do | 4,794 | 278.68 | | 23.22 |
| Sarah V. Plummer[¶] | Land | | | | |
| John Blankenbuhler | Water power | 2,700 | 100.00 | | 100.00 |
| Wm. F. Beaumount[**] | ...do | 5,200 | 184.50 | | 138.38 |
| Frederick Abel | ...do | 5,200 | 184.50 | | 46.12 |
| | | | | | 3,447.31 |

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[*] Lessee insolvent; water shut off.

[†] Perpetual free lease of water power.

[‡] Enough to propel 10 run of 4′5″ millstones.

[§] Enough to propel 15 run of 4½′ millstones.

[‖] Lease canceled June 1, 1892.

[¶] Terms five years in advance.

[**] Lease transferred to Frederick Abel March 22, 1893.

*Detailed statement of expenses incurred on Muskingum River, under the appropriation for operating and care of canals and other works of navigation, for the fiscal year ending June 30, 1893.*

## GENERAL ADMINISTRATION.

| Month. | Salaries. | | Plant. | |
|---|---|---|---|---|
| | Office force. | Lock-keepers, bridge-tender, gauge-reader, and watchman. | First cost. | Repairs. |
| July | $380.00 | $644.00 | $2.60 | $4.55 |
| August | 505.00 | 589.00 | 1,933.94 | 9.65 |
| September | 380.00 | 644.00 | 729.76 | 14.40 |
| October | 380.00 | 644.00 | 718.91 | 9.36 |
| November | 425.00 | 644.00 | 489.28 | 14.83 |
| December | 505.00 | 683.50 | 400.45 | 3.00 |
| January | 525.00 | 661.00 | 8.40 | 2.63 |
| February | 305.00 | 649.00 | 111.50 | 10.10 |
| March | 305.00 | 640.67 | 20.36 | 1.23 |
| April | 405.00 | 631.33 | 459.60 | 64.67 |
| May | 305.00 | 659.00 | 292.89 | 9.03 |
| June | 305.00 | 659.00 | 101.40 | |
| Total | 4,725.00 | 7,748.50 | 5,269.09 | 143.45 |

| Month. | Repair of buildings. | Supplies. | Transportation. | Miscellaneous. | Total. |
|---|---|---|---|---|---|
| July | | $16.33 | $3.87 | $108.81 | $1,162.16 |
| August | | 42.15 | 4.85 | 44.38 | 3,128.97 |
| September | $44.71 | 26.24 | 20.70 | 49.73 | 1,909.54 |
| October | 122.36 | 9.46 | 5.33 | 49.98 | 1,939.40 |
| November | 130.00 | 13.08 | 3.00 | 76.53 | 1,796.72 |
| December | 2.14 | 22.47 | 27.13 | 37.78 | 1,681.47 |
| January | | 28.24 | .25 | 26.83 | 1,252.35 |
| February | | 55.45 | | 23.08 | 1,154.13 |
| March | | 2.20 | 1.75 | 50.18 | 1,021.39 |
| April | 321.03 | 16.22 | | 69.10 | 1,966.95 |
| May | 135.75 | | .25 | 64.34 | 1,466.26 |
| June | | | | 27.58 | 1,092.98 |
| Total | 755.99 | 233.84 | 67.13 | 628.32 | 19,571.32 |

## U. S. DREDGE MALTA.

| Month. | Salaries. | Equipment. | Supplies. | Repairs. | Towboat. | Total. |
|---|---|---|---|---|---|---|
| July | $284.26 | | $9.30 | $33.50 | $240.00 | $567.15 |
| August | 532.70 | $76.09 | 24.95 | 73.14 | 560.00 | 1,266.88 |
| September | 573.36 | 16.05 | 98.78 | 40.17 | 600.00 | 1,328.36 |
| October | 736.86 | 9.83 | 65.89 | 172.99 | 620.00 | 1,605.57 |
| November | 537.40 | 14.10 | 46.00 | 19.63 | 600.00 | 1,217.13 |
| December | 530.72 | | 39.25 | 48.68 | 440.00 | 1,058.65 |
| January | 50.00 | | | | | 50.00 |
| February | | | | 89.79 | | 89.79 |
| March | 225.00 | 1.25 | 5.95 | 144.79 | | 376.99 |
| April | 397.37 | | 32.50 | 56.81 | | 486.68 |
| May | 484.25 | 8.60 | 32.80 | 97.25 | | 622.90 |
| June | 539.76 | | 39.75 | | | 579.51 |
| Total | 4,891.68 | 125.92 | 395.17 | 776.84 | 3,060.00 | 9,249.61 |

*Detailed statement of expenses on Muskingum River, etc.*—Continued.

### U. S. STEAMER VEGA.

| Month. | Salaries. | Equipment. | Supplies. | Repairs. | Total. |
|---|---|---|---|---|---|
| August | $179.25 | .......... | $15.71 | $30.46 | $225.42 |
| September | 348.33 | .......... | 20.40 | 11.20 | 379.93 |
| October | 354.60 | $1.35 | 29.35 | 28.88 | 414.18 |
| November | 348.33 | .......... | 8.15 | 300.60 | 657.08 |
| December | 330.05 | .......... | 24.10 | 100.57 | 454.72 |
| January | 68.25 | .......... | .......... | .......... | 68.25 |
| February | 73.75 | .......... | .......... | 4.88 | 78.63 |
| March | 109.97 | .......... | .......... | 30.03 | 140.00 |
| April | 357.50 | 7.62 | 13.75 | 20.98 | 399.85 |
| May | 357.50 | .......... | 19.40 | 12.92 | 389.82 |
| June | 360.38 | .......... | 2.50 | .50 | 363.38 |
| Total | 2,887.91 | 8.97 | 133.36 | 541.02 | 3,571.26 |

### LOCK AND DAM NO. 1.

| Month. | Labor. | Material. | Supplies. | Total. |
|---|---|---|---|---|
| July | $22.50 | $16.74 | .......... | $39.24 |
| August | 291.16 | 27.50 | .......... | 318.66 |
| September | .......... | 1.00 | .......... | 1.00 |
| November | 7.38 | .......... | .......... | 7.38 |
| December | 7.20 | .......... | .......... | 7.20 |
| February | 5.76 | .......... | .......... | 5.76 |
| April | 24.02 | .......... | $3.64 | 27.66 |
| May | 9.72 | 15.70 | .......... | 25.42 |
| Total | 367.74 | 60.94 | 3.64 | 432.32 |

### LOCK AND DAM NO. 2.

| | | | | |
|---|---|---|---|---|
| July | $4.80 | $0.25 | .......... | $5.05 |
| August | 32.05 | .......... | .......... | 32.05 |
| September | 177.11 | 223.25 | $4.10 | 404.46 |
| October | 1,270.67 | 10.80 | 13.31 | 1,294.78 |
| November | 266.25 | .70 | .......... | 266.95 |
| February | 34.38 | .......... | .......... | 34.38 |
| March | .......... | 52.17 | 2.00 | 54.17 |
| April | 6.48 | .......... | .......... | 6.48 |
| May | 28.98 | .......... | .......... | 28.98 |
| June | 42.88 | .......... | .......... | 42.88 |
| Total | 1,863.60 | 287.17 | 19.41 | 2,170.18 |

### LOCK AND DAM NO. 3.

| | | | | |
|---|---|---|---|---|
| July | $4.80 | $1.88 | .......... | $6.68 |
| August | 85.04 | .......... | .......... | 85.04 |
| September | 69.88 | 112.25 | .......... | 182.13 |
| October | .......... | .50 | .......... | .50 |
| November | 1.20 | 3.40 | .......... | 4.60 |
| December | 19.66 | 6.18 | .......... | 25.84 |
| February | 6.30 | .......... | .......... | 6.30 |
| March | 1.40 | 62.20 | $2.50 | 66.10 |
| April | .......... | .......... | 1.90 | 1.90 |
| May | 9.43 | .......... | .......... | 9.43 |
| June | 12.70 | .......... | .......... | 12.70 |
| Total | 210.41 | 186.41 | 4.40 | 401.22 |

*Detailed statement of expenses on Muskingum River, etc.*—Continued.

### LOCK AND DAM NO. 4.

| Month. | Labor. | Material. | Supplies. | Total. |
|---|---|---|---|---|
| July | $31.50 | | | $31.50 |
| August | | $0.56 | | .56 |
| September | 211.69 | 128.35 | | 340.04 |
| October | 30.30 | | | 30.30 |
| December | 15.96 | 4.48 | | 20.44 |
| January | | 4.85 | | 4.85 |
| February | 21.78 | | | 21.78 |
| March | 9.00 | 51.07 | $3.50 | 63.57 |
| April | 13.89 | | | 13.89 |
| May | 76.11 | | .50 | 76.61 |
| June | 7.74 | 3.75 | | 11.49 |
| Total | 417.97 | 193.06 | 4.00 | 615.03 |

### LOCK AND DAM NO. 5.

| Month. | Labor. | Material. | Supplies. | Total. |
|---|---|---|---|---|
| July | $3.15 | $15.02 | | $18.17 |
| August | 187.68 | 15.76 | | 203.44 |
| September | 668.40 | 587.81 | | 1,256.21 |
| October | 25.26 | | | 25.26 |
| December | 41.30 | 32.60 | | 73.90 |
| March | | 52.07 | $2.00 | 54.07 |
| Total | 925.79 | 703.26 | 2.00 | 1,631.05 |

### LOCK AND DAM NO. 6.

| Month. | Labor. | Material. | Supplies. | Total. |
|---|---|---|---|---|
| September | $28.80 | | | $28.80 |
| October | 44.64 | | | 44.64 |
| November | 18.72 | | | 18.72 |
| March | | $58.07 | $2.00 | 60.07 |
| April | | 14.91 | | 14.91 |
| May | 698.31 | 35.60 | | 733.91 |
| June | 1,382.60 | | | 1,382.60 |
| Total | 2,173.07 | 108.58 | 2.00 | 2,283.65 |

### LOCK AND DAM NO. 7.

| Month. | Labor. | Material. | Supplies. | Total. |
|---|---|---|---|---|
| August | $24.12 | | | $24.12 |
| September | 89.44 | $15.57 | | 105.01 |
| October | 247.32 | 86.19 | $4.00 | 337.51 |
| November | 133.28 | | | 133.28 |
| December | 51.73 | | | 51.73 |
| February | 54.49 | | | 54.49 |
| March | 35.73 | 52.07 | 3.80 | 91.60 |
| April | 101.07 | 24.90 | | 125.97 |
| May | 129.12 | | | 129.12 |
| June | 167.61 | 37.00 | | 204.61 |
| Total | 1,033.91 | 215.73 | 7.80 | 1,257.44 |

### LOCK AND DAM NO. 8.

| Month. | Labor. | Material. | Supplies. | Total. |
|---|---|---|---|---|
| July | $4.80 | | | $4.80 |
| August | 7.20 | | | 7.20 |
| October | | $3.30 | | 3.30 |
| January | 4.32 | | | 4.32 |
| February | 181.28 | 89.90 | | 271.18 |
| March | | 52.08 | $2.00 | 54.08 |
| April | 3.60 | | | 3.60 |
| May | 128.96 | 22.25 | | 151.21 |
| June | 18.72 | | | 18.72 |
| Total | 348.88 | 167.53 | 2.00 | 518.41 |

*Detailed statement of expenses on Muskingum River, etc.*—Continued.

LOCK AND DAM NO. 9.

| Month. | Labor. | Material. | Supplies. | Total. |
|---|---|---|---|---|
| July | .......... | $4.60 | .......... | $4.60 |
| February | $284.77 | .......... | .......... | 284.77 |
| March | 5.88 | .......... | $2.00 | 7.88 |
| May | 72.90 | 4.20 | .......... | 77.10 |
| June | .......... | 2.20 | .......... | 2.20 |
| Total | 363.55 | 11.00 | 2.00 | 376.55 |

LOCK AND DAM NO. 10.

| Month. | Labor. | Material. | Supplies. | Total. |
|---|---|---|---|---|
| July | $210.75 | $6.91 | $0.25 | $217.91 |
| August | 72.30 | 4.00 | .......... | 76.30 |
| September | 420.26 | 186.86 | .......... | 607.12 |
| October | 364.28 | 162.15 | .......... | 526.43 |
| November | 53.34 | 80.78 | .......... | 134.12 |
| January | .......... | .90 | .......... | .90 |
| February | 10.80 | .......... | .......... | 10.80 |
| March | 17.64 | 292.25 | 2.00 | 311.89 |
| April | 20.07 | 3.75 | .......... | 23.82 |
| May | 158.55 | 10.92 | .......... | 169.47 |
| June | 94.32 | .......... | .......... | 94.32 |
| Total | 1,422.31 | 748.52 | 2.25 | 2,173.08 |

SUMMARY.

| | | | |
|---|---|---|---|
| General administration | $19,571.82 | Lock and Dam No. 6 | $2,283.65 |
| U. S. dredge Malta | 9,249.61 | Lock and Dam No. 7 | 1,257.44 |
| U. S. steamer Vega | 3,571.26 | Lock and Dam No. 8 | 518.41 |
| Lock and Dam No. 1 | 432.32 | Lock and Dam No. 9 | 376.55 |
| Lock and Dam No. 2 | 2,170.18 | Lock and Dam No. 10 | 2,173.08 |
| Lock and Dam No. 3 | 401.22 | | |
| Lock and Dam No. 4 | 615.03 | Total | 44,251.10 |
| Lock and Dam No. 5 | 1,631.05 | | |

*Detailed statement and cost of dredging on the Muskingum River, under the appropriation for operating and care of canals and other works of navigation, for the fiscal year ending June 30, 1893.*

| Date. | Locality. | Materials excavated. | Total cost. |
|---|---|---|---|
| July | Marietta, Ohio | 1,050 yards gravel, sand, and mud, at 10 cents | $105.00 |
| | ......do | 4 piling, at $5 | 20.00 |
| | ......do | 300 linear feet cofferdam, at 50 cents | 150.00 |
| | ......do | 2 stones at, $8.57½ | 17.15 |
| | Devols Dam, Ohio | 400 yards gravel, sand, and mud, at 10 cents. | 40.00 |
| | Lowell, Ohio | 4,700 yards mud, at 5 cents | 235.00 |
| August | ......do | 2,850 yards mud, at 5 cents | 142.50 |
| | ......do | 1 piling | 9.36 |
| | Devols Dam, Ohio | 4,260 yards gravel, sand, and mud, at 15 cents. | 639.00 |
| | Marietta, Ohio | 2,800 yards gravel, sand, and mud, at 17 cents. | 476.00 |
| September | ......do | 1,785 yards gravel, sand, and mud, at 15 cents. | 267.75 |
| | Bakers Run, Ohio | 1,800 yards gravel, sand, and mud, at 15 cents. | 270.00 |
| | Luke Chute, Ohio | 3 stones at $10 | 30.00 |
| | ......do | 1 snag | 10.63 |
| | Rokeby Lock, Ohio | 5,500 yards gravel, sand, and mud, at 12 cents. | 660.00 |
| | ......do | 1 sycamore stump | 10.00 |
| | ......do | 4 snags, at $10 | 40.00 |
| | ......do | 80 linear feet cofferdam, at 50 cents | 40.00 |
| October | ......do | 5,615 yards gravel, sand, and mud, at 15 cents. | 842.25 |
| | ......do | 110 yards stone, at 50 cents | 55.00 |
| | ......do | 13 snags, at $6 | 78.00 |
| | ......do | 71 logs, at $1 | 71.00 |
| | McConnellsville, Ohio | 3,728¾ yards gravel, sand, and mud, at 15 cents | 559.31 |
| November | ......do | 1,400 yards gravel, at 17 cents | 238.00 |
| | ......do | 3 logs, at $5 | 15.00 |
| | ......do | 4 snags, at $13.66 | 54.64 |

*Detailed statement and cost of dredging on the Muskingum River, etc.*—Continued.

| Date. | Locality. | Materials excavated. | Total cost. |
|---|---|---|---|
| November | Beverly, Ohio | 600 yards gravel, at 17 cents | $102.00 |
|  | Luke Chute, Ohio | 45 linear feet cofferdam, at $1 | 45.00 |
|  | do | 1,740 yards gravel, an d mud, at 15 cents | 261.00 |
|  | Taylorsville, Ohio | 2,450 yards gravel, at 17 cents | 416.50 |
|  | do | 3 logs, at $5 | 15.00 |
|  | do | 7 stones, at $10 | 70.00 |
| December | do | 9,245 yards gravel, sand, and mud, at 11 cents | 1,016.95 |
|  | do | 6 stones, at $6.95 | 41.70 |
| January |  | Repairs on dredge | 50.00 |
| February |  | do | 89.79 |
| March |  | do | 376.99 |
| April |  | do | 355.43 |
|  | Zanesville, Ohio | 2,625 yards gravel, sand, and mud, at 5 cents | 131.25 |
| May | do | 4,450 yards gravel, sand, and mud, at 5 cents | 222.50 |
|  | Taylorsville, Ohio | 5,338⅔ yards gravel, sand, and mud, at 7½ cents | 400.40 |
| June | do | 7,207 yards gravel, sand, and mud, at 7 cents | 504.49 |
|  | do | 80 linear feet cofferdam, at 90 cents | 72.00 |
|  | do | 4 logs at 75½ cents | 3.02 |
|  |  | Total | 9,249.61 |

*Commerce of Muskingum River, during the calendar year ending December 31, 1892.*

LOCK NO. 1.

| Month. | Steamboats. | Barges. | Miscellaneous. | Total. | Number of lockages. |
|---|---|---|---|---|---|
| February | 1 | 11 | 13 | 25 | 25 |
| March | 5 | 8 | 7 | 20 | 20 |
| April | 58 | 17 | 66 | 141 | 141 |
| May | 54 | 10 | 31 | 95 | 95 |
| June | 81 | 13 | 41 | 135 | 115 |
| July | 74 | 12 | 8 | 94 | 94 |
| August | 82 | 12 | 1 | 95 | 95 |
| September | 71 | 12 | 7 | 90 | 90 |
| October | 46 | 18 | 10 | 74 | 74 |
| November | 72 | 28 | 9 | 109 | 109 |
| December | 58 | 31 | 4 | 93 | 93 |
| Total | 602 | 172 | 197 | 971 | 951 |

LOCK NO. 2.

| Month. | Steamboats. | Barges. | Miscellaneous. | Total. | Number of lockages. |
|---|---|---|---|---|---|
| February | 37 | 11 | 4 | 52 | 48 |
| March | 54 | 8 | 6 | 68 | 66 |
| April | 54 | 9 | 2 | 65 | 64 |
| May | 69 | 17 | 5 | 91 | 91 |
| June | 82 | 23 | 7 | 112 | 112 |
| July | 72 | 20 | 7 | 99 | 99 |
| August | 89 | 11 | 4 | 104 | 104 |
| September | 84 | 14 | 5 | 103 | 95 |
| October | 38 | 13 | 4 | 55 | 55 |
| November | 102 | 17 | 3 | 122 | 111 |
| December | 64 | 28 | 4 | 96 | 87 |
| Total | 745 | 171 | 51 | 967 | 932 |

LOCK NO. 3.

| Month. | Steamboats. | Barges. | Miscellaneous. | Total. | Number of lockages. |
|---|---|---|---|---|---|
| February | 36 | 5 | 3 | 44 | 43 |
| March | 54 | 9 |  | 63 | 63 |
| April | 54 | 7 | 1 | 62 | 62 |
| May | 65 | 13 | 1 | 79 | 75 |
| June | 85 | 16 | 2 | 103 | 92 |
| July | 70 | 14 | 2 | 86 | 86 |
| August | 85 | 7 | 2 | 94 | 94 |
| September | 84 | 16 | 3 | 103 | 103 |
| October | 38 | 8 | 4 | 50 | 50 |
| November | 102 | 10 | 5 | 117 | 102 |
| December | 59 | 15 | 1 | 75 | 74 |
| Total | 732 | 120 | 24 | 876 | 844 |

*Commerce of Muskingum River, during calendar year ending December 31, 1892*—Cont'd.

### LOCK NO. 4.

| Month. | Steamboats. | Barges. | Miscellaneous. | Total. | Number of lockages. |
|---|---|---|---|---|---|
| February | 12 | 4 | 1 | 17 | 17 |
| March | 14 | 10 | 4 | 28 | 26 |
| April | 20 | 9 | 2 | 31 | 31 |
| May | 31 | 11 | 2 | 44 | 40 |
| June | 41 | 14 | 3 | 58 | 54 |
| July | 29 | 8 | 7 | 44 | 43 |
| August | 52 | 11 | 12 | 75 | 74 |
| September | 49 | 26 | 6 | 81 | 73 |
| October | 34 | 6 | 4 | 44 | 42 |
| November | 43 | 9 | 3 | 55 | 50 |
| December | 25 | 20 | 3 | 48 | 42 |
| Total | 350 | 128 | 47 | 525 | [illegible] |

### LOCK NO. 5.

| Month. | Steamboats. | Barges. | Miscellaneous. | Total. | Number of lockages. |
|---|---|---|---|---|---|
| May | 31 | 6 | 3 | 40 | 35 |
| June | 42 | 8 | 4 | 54 | 46 |
| July | 47 | 5 | 15 | 67 | 56 |
| August | 61 | 10 | 4 | 75 | 71 |
| September | 54 | 16 | 6 | 76 | 74 |
| October | 60 | 2 | 7 | 69 | 64 |
| November | 38 | 10 | 8 | 56 | 47 |
| December | 18 | 14 | 2 | 34 | 24 |
| Total | 351 | 71 | 49 | 471 | 417 |

### LOCK NO. 6.

| Month. | Steamboats. | Barges. | Miscellaneous. | Total. | Number of lockages. |
|---|---|---|---|---|---|
| April | 9 | 2 | 3 | 14 | 14 |
| May | 32 | 3 | 5 | 40 | 40 |
| June | 43 | 4 | 6 | 53 | 49 |
| July | 47 | 8 | 21 | 76 | 62 |
| August | 60 | 4 | 18 | 82 | 77 |
| September | 54 | 9 | 6 | 69 | 59 |
| October | 62 | 2 | 5 | 69 | 65 |
| November | 40 | 10 | 7 | 57 | 48 |
| December | 19 | 14 | 1 | 34 | 26 |
| Total | 366 | 56 | 72 | 494 | 440 |

### LOCK NO. 7.

| Month. | Steamboats. | Barges. | Miscellaneous. | Total. | Number of lockages. |
|---|---|---|---|---|---|
| January | 5 | 2 | 3 | 10 | 6 |
| February | 4 | 1 | ........ | 5 | 5 |
| March | 31 | 1 | ........ | 32 | 32 |
| April | 30 | 12 | 3 | 45 | 40 |
| May | 32 | 5 | 4 | 41 | 40 |
| June | 43 | 8 | 6 | 57 | 53 |
| July | 44 | 1 | 14 | 59 | 54 |
| August | 60 | 5 | 5 | 70 | 68 |
| September | 55 | 10 | ........ | 65 | 62 |
| October | 61 | 6 | 6 | 73 | 67 |
| November | 46 | 13 | 2 | 61 | 51 |
| December | 21 | 16 | 2 | 39 | 29 |
| Total | 432 | 80 | 45 | 557 | 507 |

*Commerce of Muskingum River, during calendar year ending December 31, 1892*—Cont'd.

### LOCK NO. 8.

| Month. | Steamboats. | Barges. | Miscellaneous. | Total. | Number of lockages. |
|---|---|---|---|---|---|
| January | 11 | | | 11 | 11 |
| February | 30 | | | 30 | 30 |
| March | 85 | 6 | 4 | 95 | 90 |
| April | 85 | 7 | 1 | 93 | 93 |
| May | 77 | 1 | 4 | 82 | 82 |
| June | 98 | 2 | 6 | 106 | 106 |
| July | 105 | 1 | | 106 | 103 |
| August | 124 | 9 | 3 | 136 | 136 |
| September | 107 | 2 | 12 | 121 | 121 |
| October | 127 | 2 | | 129 | 129 |
| November | 84 | 4 | 4 | 92 | 90 |
| December | 61 | 3 | 4 | 68 | 65 |
| Total | 994 | 37 | 38 | 1,069 | 1,056 |

### LOCK NO. 9.

| | | | | | |
|---|---|---|---|---|---|
| January | 13 | | | 13 | 13 |
| February | 30 | | | 30 | 30 |
| March | 86 | 2 | 2 | 90 | 88 |
| April | 81 | 9 | 5 | 95 | 92 |
| May | 78 | 11 | | 89 | 85 |
| June | 108 | 14 | 7 | 129 | 122 |
| July | 103 | 6 | 14 | 123 | 121 |
| August | 125 | 9 | 10 | 144 | 144 |
| September | 108 | 8 | 5 | 121 | 118 |
| October | 124 | 10 | 13 | 147 | 144 |
| November | 83 | 5 | 10 | 98 | 93 |
| December | 56 | 1 | 2 | 59 | 59 |
| Total | 995 | 75 | 68 | 1,138 | 1,109 |

### LOCK NO. 10.

| | | | | | |
|---|---|---|---|---|---|
| January | 12 | | | 12 | 12 |
| February | 48 | | | 48 | 48 |
| March | 80 | 1 | | 81 | 81 |
| April | 76 | | | 76 | 76 |
| May | 76 | 2 | | 78 | 78 |
| June | 101 | 3 | | 104 | 104 |
| July | 117 | | 1 | 118 | 117 |
| August | 118 | 8 | 3 | 129 | 126 |
| September | 99 | | 6 | 105 | 104 |
| October | 110 | | | 110 | 110 |
| November | 72 | 3 | | 75 | 75 |
| December | 50 | | 4 | 54 | 54 |
| Total | 959 | 17 | 14 | 990 | 985 |

### SUMMARY.

| | | | | | |
|---|---|---|---|---|---|
| Lock No.— | | | | | |
| 1 | 602 | 172 | 197 | 971 | 951 |
| 2 | 745 | 171 | 51 | 967 | 932 |
| 3 | 732 | 120 | 24 | 876 | 844 |
| 4 | 350 | 128 | 47 | 525 | 498 |
| 5 | 351 | 71 | 49 | 471 | 417 |
| 6 | 366 | 56 | 72 | 494 | 440 |
| 7 | 432 | 80 | 45 | 557 | 507 |
| 8 | 994 | 37 | 38 | 1,069 | 1,056 |
| 9 | 995 | 75 | 68 | 1,138 | 1,109 |
| 10 | 959 | 17 | 14 | 990 | 985 |
| Total | 6.526 | 927 | 605 | 8,058 | 7,739 |

*List showing amount of principal items of freight and the number of passengers carried on the Muskingum River for the calendar year ending December 31, 1892.*

| Article. | Amount. | Article. | Amount. |
|---|---|---|---|
| Passengers .................. number.. | 55,536 | Wool .......................... tons.. | 1,1[illegible] |
| General merchandise ............ tons.. | 7,264 | Lumber ........................do ... | 9,6[illegible] |
| Coal ..............................do ... | 7,148 | Brick.............................do ... | 763 |
| Live stock.........................do ... | 1,100 | Hay ...............................do ... | 5,5[illegible] |
| Oil...................................do ... | 13,200 | Salt ...............................do ... | 5[illegible] |
| Wheat..............................do ... | 1,907 | Potatoes..........................do ... | 1,671 |
| Corn...............................do ... | 2,113 | | |

The above statement of the commerce of the Muskingum River is complete, but is only for part of the fiscal year, as the locks were shut off for repairs and there was no through navigation until May 6, 1892.

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*List of steamboats (stern-wheel) plying on the Muskingum River, between Zanesville and Marietta, Ohio.*

| Name. | Length. | Breadth. | Depth. | Draft. | Tonnage. |
|---|---|---|---|---|---|
| | *Feet.* | *Feet.* | *Feet.* | *Inches.* | |
| Annie Laurie.................................. | 141 | 32½ | 5½ | 30 | 200 |
| Lizzie Cassel.................................. | 138 | 31½ | 4½ | 22 | 176 |
| Bessie Siler.................................... | 95 | 16 | 3 | 24 | 50 |
| T. M. Bayne.................................... | 120 | 24 | 3½ | 20 | 115 |
| R. B. Kendall.................................. | 105 | 18 | 3 | 28 | 100 |
| Sonoma.......................................... | 125 | 20 | 3½ | 23 | 116 |
| Water Maiden ................................. | 69 | 12 | 2½ | 24 | 24 |
| Emma............................................. | 76 | 14 | 2½ | 26 | 25 |
| Mary H .......................................... | 118 | 18 | 3 3/16 | 22 | 62 |
| Florence ........................................ | 80 | 16 | 3 | 24 | 42 |

## F F 15.

## PRELIMINARY EXAMINATION OF OHIO RIVER AT OR NEAR ELIZABETHTOWN, ILL., FOR THE PURPOSE OF DETERMINING THE MOST PRACTICABLE METHOD OF IMPROVING THE HARBOR AT THAT PLACE.

[Printed in House Ex. Doc. No. 111, Fifty-second Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
*Washington, D. C., December 5, 1892.*

SIR: I have the honor to submit the accompanying copy of report, dated August 31, 1892, by Maj. Amos Stickney, Corps of Engineers, of results of a preliminary examination of Ohio River at or near Elizabethtown, Ill., for the purpose of determining the most practicable method of improving the harbor at that place, made to comply with the terms of the river and harbor act approved July 13, 1892.

Major Stickney states that—

> In view of the fact that the desired improvement would establish river communication for a town of about 800 inhabitants and improve general navigation by providing a channel wider and more nearly straight than the one now in use, and do away with a troublesome crossing, it is, in my opinion, an improvement worthy to be made by the General Government, provided that the cost is not unreasonable.

The views of Major Stickney are concurred in by the division engineer and by this office.

The survey necessary to prepare plan of improvement is estimated to cost $600.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
*Brig. Gen., Chief of Engineers.*

Hon. S. B. ELKINS,
*Secretary of War.*

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## REPORT OF MAJ. AMOS STICKNEY, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
*Cincinnati, Ohio, August 31, 1892.*

GENERAL: I have the honor to submit the following report upon a preliminary examination of the Ohio River at or near Elizabethtown, Ill., for the purpose of determining the most practicable method of improving the harbor at that place, assigned to my charge by letter of the Chief of Engineers, U. S. Army, dated July 14, 1892. I examined the locality August 10. Elizabethtown is opposite the lower end of Hurricane Island. This island is about 4 miles long and divides the Ohio River into two channels, only one of which, that on the south side, is navigable at a low-water stage.

Previous to 1860, so I was informed by some of the old residents of Elizabethtown, the main channel of the river was on the north side of the island. It is said to have been unobstructed and better for navigation than the channel now used. By some change in the flow of the river above Hurricane Island the bar above the island on the right-hand shore, known as Half-Moon Bar, increased in size and extended down stream until it partially closed the entrance to the channel on the north side of the island, and the main channel changed to the south side of the island. As a consequence of this change the old channel has shoaled very much, and in time of low-water boats can only approach Elizabethtown from below. This shoaling is still going on, and at the time of my visit there was a dry bar extending nearly across the channel just above the Elizabethtown landing, and I was informed that the river below the landing had shoaled to such an extent that it was feared that communication by boats would be entirely cut off.

The people of Elizabethtown desire to have the channel restored to the north side of the island. There are some important changes going on now in the channel at the head of the island. There is a bar known as Walkers Bar making out from the left-hand shore and extending down into the channel on the south side of the island, just as Half-Moon Bar extended down into the north channel. Walkers Bar, I am informed, has recently extended downstream quite rapidly, and at the time I passed that point the passage into the south channel was quite narrow, and the towhead at the upper end of Hurricane Island was cutting. It would seem as if there were some uncertainty as to which side of the island the main body of water would be forced by the growth of the bars above, and it is not at all improbable that by an artificial direction of the channel at a not unreasonable cost, the main channel could be restored to the north side of the island. Such restoration would not only be a matter of great importance to Elizabethtown in bringing the navigable channel back to the town, but would be beneficial to through navigation, especially for tows, as it would do away with two crossings, one above and one below the island. This matter was discussed in a report of the late Lieut. Col. W. E. Merrill, Corps of Engineers, dated January 15, 1881, which can be found in the Annual Report of the Chief of Engineers for the year 1881, page 1922.

In the fall of 1880 a survey of the locality was made under Colonel Merrill's direction. In his report Colonel Merrill expressed considerable doubt as to the propriety of attempting to change the channel of the river back to the north side of the island, and considered that it would be a difficult and costly undertaking. I believe that the conditions have materially changed since the survey of 1880, especially in the extension of Walkers Bar down into the south channel, and that the forcing of the water back north of the island would not now be so difficult as it would have been at the time of Colonel Merrill's report. In view of the fact that the desired improvement would establish river communication for a town of about 800 inhabitants and improve general navigation by providing a channel wider and more nearly straight than the one now in use, and do away with a troublesome crossing, it is, in my opinion, an improvement worthy to be made by the General Government, provided that the cost is not unreasonable. To form an estimate of the cost will require further survey, a principal feature of which should be to ascertain the cause for the formation and growth of Half-Moon Bar.

The cost of this survey is estimated at $600.

Very respectfully, your obedient servant,

AMOS STICKNEY,
*Major of Engineers.*

Brig. Gen. THOMAS L. CASEY,
*Chief of Engineers, U. S. A.*

(Through Col. O. M. Poe, Corps of Engineers, Division Engineer, Northwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
*Detroit, Mich., September 2, 1892.*

Respectfully forwarded to the office of Chief of Engineers.

I concur in the opinion of the district engineer, and approve his estimate of the cost of a survey.

O. M. POE,
*Colonel, Corps of Engineers,*
*Division Engineer, Northwest Division.*

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## F F 16.

### PRELIMINARY EXAMINATION OF HARBOR AT EVANSVILLE, IND.

[Printed in House Ex. Doc. No. 115, Fifty-second Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
*Washington, D. C., December 5, 1892.*

SIR: I have the honor to submit the inclosed copy of report of August 31, 1892, by Maj. Amos Stickney, Corps of Engineers, of the results of preliminary examination of harbor at Evansville, Ind., made to comply with provisions of the river and harbor act approved July 13, 1892.

Major Stickney states that, in his opinion, the locality is worthy of improvement by the General Government, and his opinion is concurred in by the division engineer and by this office.

An estimate of $300 is submitted as the cost of the survey necessary to prepare plan and project for the improvement.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
*Brig. Gen., Chief of Engineers.*

HON. S. B. ELKINS,
*Secretary of War.*

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## REPORT OF MAJ. AMOS STICKNEY, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
*Cincinnati, Ohio, August 31, 1892.*

GENERAL: I have the honor to submit the following report upon a preliminary examination of the harbor at Evansville, Ind., assigned to my charge by letter of Chief of Engineers, U. S. Army, dated July 14, 1892. I made an examination of the harbor August 9, 1892, and by appointment met Messrs. John Gilbert and T. W. Yenemann, the chairman and secretary of the Ohio river commission for the State of Indiana, and others interested in the navigation of the river. Evansville, the second city in size in the State of Indiana, is situated on the right bank of the Ohio River, in a very sharp bend. By the bending of the river a long peninsula is formed on the Kentucky side. Near the base of this peninsula, about 6 miles above Evansville, the neck of land measures something over a mile across from river to river. The banks of the river, on both sides of the neck, especially on the upper side, are being cut away by the current, and there are depressions in the land through which in floods the water of the river flows before the entire peninsula is submerged, though the submergence is general at a higher stage.

In 1878–'79 a dike was built by the United States extending out from the Kentucky shore to contract the low-water flow just above Evansville, and throw the channel against the Indiana shore. This object was accomplished by the dike, but as the public landing of Evansville is about 4,000 feet below the downstream end of the dike the water has a chance to spread over towards the Kentucky shore, a tendency which is probably increased by the abruptness of the sharp bend to the left, which tends to cause the water to fall away from the right bank. The effect is that the channel immediately in front of the public landing is getting shoaler, and as the river gets down to a low stage it is necessary to spar the wharf boats out some distance from the shore. The questions that are presented for consideration, then, are (1) the possibility of the river cutting through the neck of land about 6 miles above Evansville, leaving that city inland; (2) the lack of navigable depth of water in front of the public landing.

With regard to the first question, the action of the river in cutting the banks and eroding the surface is very much slower than in similar cases on the lower Mississippi River, on accout of the nature of the soil, and the lesser depth and volume of water; and as the neck of land across which the water flows in floods is something over a mile in width there is no probable immediate danger of a cut-off. The cutting, however, is going on year after year, and each year brings the possibility of a cut-off nearer to hand, and probably increases the cost of any work that might be undertaken to prevent the cut-off.

The grave results of such a disaster as a cut-off would be to the city of Evansville render it advisable to keep the matter in view, and would, I think, justify taking immediate steps to keep the river in its present channel. This matter was discussed in two reports of the late Lieut. Col. W. E. Merrill, Corps of Engineers, to which I invite attention, and which can be found in the annual reports of the Chief of Engineers for 1888, p. 1716, and for 1891, p. 2382. Colonel Merrill presented two plans for the protection of the peninsula. One contemplated the construction of an earthen levee to extend from the high ground at the base of the peninsula to the point opposite Evansville, a distance of about 6½ miles, at an estimated cost of from $305,000 to $317,000, estimates being made on two lines. The other plan was to purchase a strip of land down the peninsula and plant it with trees and bushes to break the force of the current across the peninsula. The estimate for the latter plan, with fencing, was $49,000. In neither of these plans was any provision made for preventing the cutting away of the river banks in the bends above and below the neck of the peninsula, the plans looking only to the prevention of erosion and lowering of the surface of the land, it being stated in Colonel Merrill's report that the question of protecting the banks might be taken up at a later time.

In my opinion the holding of the banks is a vital point in any plan for preventing a cut-off. If the width of the neck of land can be maintained as it is there is but little probability of the river creating a main channel through the neck by gradual erosion of the surface. This opinion was also held by Colonel Merrill. A cut-off is formed by the close approach of the two bends on the opposite sides of the neck of land when the difference in level of water surface, due to the slope of the river surface for the entire distance around the peninsula, causes a steep descent of water across the narrow neck. The water passing across the neck falls over the bank into the lower bend and rapidly cuts the bank away. The rapidity of this cutting depends upon the volume of water, depth of fall, and nature of the soil. As stated before, it is probable that the neck of the peninsula opposite Evansville has not yet approached a condition of great immediate danger, but it would be a difficult matter to determine just when a dangerous point might be reached, and it would certainly be wise to take the matter in hand before the danger approaches too closely. The prevention of the erosion of the surface of the land would certainly be desirable, but that is a matter which more directly affects the local property owners, and I believe they could easily and at small cost prevent much damage by adopting the plan suggested by Colonel Merrill of planting trees and bushes upon a strip of land down the peninsula. Each property owner could devote a small area to this purpose and increase the value of his land.

The work that I would recommend would be the protection of the bank in the upper bend for a distance of about 15,000 feet by short sloping spur dikes placed at proper intervals. The protection of the lower bend is not of as much importance at present, and might be deferred. With regard to the second question, relating to the improvement of the river in front of the public landing at Evansville, I would say that this is a matter in which the navigation interests are more immediately interested. The desired improvement could, in my opinion, be best effected by the construction of a dike starting from a point opposite the public landing and extending from the Kentucky shore in a direct line across the river to a point about 1,200 feet from the low-water line of the Indiana shore. In my opinion the locality is one worthy of improvement by the General Government, for the reason that Evansville is one of the most important cities on the lower Ohio River and has a very considerable river commerce, being the terminus of several lines of packets and an important point for through lines.

The preservation of the channel around the peninsula is a matter affecting the whole commerce of the river. This vicinity has been surveyed and the important changes that have taken place in the last five or six years can be determined by a resurvey of certain portions. I recommend that this survey be made, and estimate the cost at $300.

Very respectfully, your obedient servant,

AMOS STICKNEY,
*Major of Engineers.*

Brig. Gen. THOMAS L. CASEY,
*Chief of Engineers, U. S. A.*

(Through Col. O. M. Poe, Corps of Engineers, Division Engineer, Northwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
*Detroit, Mich., September 2, 1892.*

Respectfully forwarded to the office of the Chief of Engineers.

I concur in the opinion of the district engineer, that the harbor at Evansville, Ind., is worthy of improvement by the General Government, and recommend that the sum of $300 be allotted for the purposes of the requisite survey.

O. M. POE,
*Colonel, Corps of Engineers,*
*Division Engineer, Northwest Division.*

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## FF 17.

### PRELIMINARY EXAMINATION OF OHIO RIVER BETWEEN THE CITIES OF LUDLOW AND COVINGTON, IN KENTUCKY, AND CINCINNATI, OHIO, FROM THE CHESAPEAKE AND OHIO RAILWAY BRIDGE TO THE CINCINNATI SOUTHERN RAILWAY BRIDGE TO PREVENT WASHING AND DAMAGE TO BANKS ON KENTUCKY SHORE.

[Printed in House Ex. Doc. No. 157, Fifty-second Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
*Washington, D. C., December 23, 1892.*

SIR: I have the honor to submit the accompanying copy of report, dated December 19, 1892, by Maj. Amos Stickney, Corps of Engineers, of the results of a preliminary examination of the "Ohio River between the cities of Ludlow and Covington, in Kentucky, and Cincinnati, Ohio, from the Chesapeake and Ohio Railway Bridge to the Cincinnati Southern Railway Bridge, to prevent washing and damage to banks on Kentucky shore," made to comply with provisions of the river and harbor act approved July 13, 1892.

It is the opinion of Major Stickney, for reasons stated, that this locality is not worthy of improvement by the General Government, and this opinion is concurred in by the division engineer and by this office.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
*Brig. Gen., Chief of Engineers.*

Hon. S. B. ELKINS,
*Secretary of War.*

## REPORT OF MAJ. AMOS STICKNEY, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
*Cincinnati, Ohio, December 19, 1892.*

GENERAL: I have the honor to submit the following report upon a preliminary examination of the Ohio River between the cities of Ludlow and Covington, in Kentucky, and Cincinnati, Ohio, from the Chesapeake and Ohio Railway Bridge to the Cincinnati Southern Railway Bridge to prevent washing and damage to banks on Kentucky shore. The examination was made by my assistant, First Lieut. H. F. Hodges, Corps of Engineers, a copy of whose report is transmitted herewith. I have also inspected the locality. The facts of the case are stated in Lieutenant Hodges's report.

The wearing away of the upper part of the river bank, which is of clay and sand, is undoubtedly due to the fact that it is in a pretty sharp bend of the river. The lower part of the bank, which is of rock, for 8 or 10 feet above low water, can not wear away very rapidly, and therefore the channel of the river is not materially affected. This is not a matter therefore relating to the navigation of the river or the benefit of the general public, but rather the protection of property belonging to the cities or private citizens of Ludlow and West Covington. While it would undoubtedly be greatly to the benefit of those directly interested to have this property protected, it has not been the policy of the General Government to construct works which had for their sole object such protection of private property, protection which was not incidental to the attainment of some benefit for the general public, as for instance, the prevention of a material and injurious change in the channel of the river. In view of the above facts, therefore, I am compelled to say that I do not deem the improvement one worthy to be made by the General Government.

Very respectfully, your obedient servant,

AMOS STICKNEY,
*Major of Engineers.*

Brig. Gen. THOMAS L. CASEY,
*Chief of Engineers, U. S. A.*

(Through Col. O. M. Poe, Corps of Engineers, Division Engineer, Northwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
*Detroit, Mich., December 21, 1892.*

Respectfully forwarded to the office of the Chief of Engineers.

For the reasons assigned by the district engineer. I concur in his opinion that the Ohio River, between the cities of Ludlow and Covington, in Kentucky, and Cincinnati, Ohio, is not worthy of improvement by the General Government.

O. M. POE,
*Colonel, Corps of Engineers, etc.,*
*Division Engineer, Northwest Division.*

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## REPORT OF FIRST LIEUT. HARRY F. HODGES, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
*Cincinnati, Ohio, October 7, 1892.*

SIR: I have the honor to make the following report of the preliminary examination of the Ohio River between the cities of Ludlow and Covington, in Kentucky, and Cincinnati, Ohio, from the Chesapeake and Ohio Railway Bridge to the Cincinnati

Southern Railway Bridge, to prevent wasting and damage to banks on Kentucky shore. This examination was ordered by the river and harbor act of July 13, 1892, and was made by me under your orders on October 6, 1892.

The distance between the points named, measured along the Kentucky bank, is about 1¼ miles. The stretch forms part of the concave bank of an abrupt bend of the Ohio River. The action of the current has caused a noticeable and dangerous erosion, reducing the width of the bank at the top so much that there is now scarcely room enough for the river road, which formerly had ample space between the hill on the one side and the bank on the other. People living in the vicinity state that there was a width of 60 feet where there is now barely 20 feet, and that the narrowing has been most marked in the last few years.

The material of the bank is a sandy clay, more or less covered with fragments of rock, a ledge of which crops out about 20 feet below the crest of the slope. The base rests on solid rock for a large part, if not the whole, of the distance. The profile shows an abrupt slope near the top and for about 30 feet down, and a more gentle slope from there to the water's edge. The total height of the crest above low water is about 60 feet.

The worst point is opposite the town of West Covington, a short distance below the outlet of the Covington sewer. Here the earth of the slope has been so washed as to leave none visible, the face being covered with fragments of broken stone, which still allow wasting of the slope through the interstices. These fragments of stone come partly from the ledge near the top, which has broken away as the earth underneath has been washed out, and partly from the ledge below, where quarrying has been permitted. An attempt has been made by one of the residents to preserve the slope by building a retaining wall to hold up the upper part. This wall was apparently founded on the upper ledge of rock, and has almost entirely disappeared, the part now remaining being some distance out from the crest of the present bank.

While this part of the slope is in the worst condition, the whole of it is stated to be wasting more or less, and its appearance bears out the statement. Some of the people lay the blame for the injury on certain business establishments on the opposite shore, which, it is said, are filling in the site of their works, thus accentuating the convexity of their bank and forcing the current toward the Kentucky shore with more than its natural strength. The piers of the Chesapeake and Ohio Bridge are also spoken of as adding to the trouble. The natural concavity of the bank seems, however, sufficient to account for the wasting.

Whatever the cause may be the effect is serious and threatens to carry away the river road entirely unless checked. This would be a material loss not only to the property owners along it, but to the town of Ludlow, which would be deprived of its most convenient outlet. It should be stopped, undoubtedly, if possible without too great expenditure.

The channel of the river does not seem to have been affected to any noticeable extent by the erosion of the bank. The ledge of rock along the foot has not apparently washed at all, while the cutting away of the bank higher up has not been rapid enough to change the channel. The benefit to be derived from any improvement would be purely a local one. The work should properly be undertaken by the authorities of Covington and Ludlow rather than by the General Government.

The locality does not seem worthy of improvement by the United States within the meaning of the act. * * *

Very respectfully, your obedient servant,

HARRY F. HODGES,
*First Lieutenant of Engineers.*

Maj. AMOS STICKNEY,
*Corps of Engineers.*

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## F F 18.

## PRELIMINARY EXAMINATION OF LITTLE MIAMI RIVER, OHIO, WITH THE VIEW OF AFFORDING AN ICE HARBOR.

[Printed in House Ex. Doc. No. 68, Fifty-second Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
*Washington, D. C., December 5, 1892.*

SIR: I have the honor to submit the accompanying copy of report dated October 18, 1892, by Maj. Amos Stickney, Corps of Engineers, of the results of a preliminary examination of Little Miami River, Ohio, with the view of affording an ice harbor, made to comply with provisions of the river and harbor act approved July 13, 1892.

It is the opinion of Major Stickney, concurred in by the division engineer and by this office, that the locality is not worthy of improvement by the General Government for the purpose named.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
*Brig. Gen., Chief of Engineers.*

Hon. S. B. ELKINS,
*Secretary of War.*

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REPORT OF MAJOR AMOS STICKNEY, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
*Cincinnati, Ohio, October 18, 1892.*

GENERAL: I have the honor to submit the following report upon a preliminary examination of the Little Miami River, Ohio, with the view of forming an ice harbor. This examination was made by my assistant, First Lieut. H. F. Hodges, Corps of Engineers, a copy of whose report is transmitted herewith.

The Little Miami at its mouth is, in low water, an exceedingly small stream. As stated in Lieutenant Hodges's report, a channel 20 feet wide and 1 foot deep could not be found when the Cincinnati gauge was at 4.8 feet, which corresponds to 2.8 feet above low water. The sketch* accompanying the report shows how the mouth of the river is obstructed by a bar. To form a harbor here that would be of any use, this bar would have to be dredged out, but as the Ohio River channel is on the Kentucky side the area, if dredged, would immediately fill up again. The location is, in my opinion, entirely unsuitable for the formation of a harbor, and I must therefore concur in the statement of Lieutenant Hodges that it is not worthy of improvement by the General Government for the purpose named.

Very respectfully, your obedient servant,

AMOS STICKNEY,
*Major of Engineers.*

Brig. Gen. THOMAS L. CASEY,
*Chief of Engineers, U. S. A.*
(Through Col. O. M. Poe, Corps of Engineers, Division Engineer, Northwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
*Detroit, Mich., October 25, 1892.*

Respectfully forwarded to the office of the Chief of Engineers.

I concur in the opinion of the district engineer that the locality is not worthy of improvement by the General Government.

O. M. POE,
*Colonel, Corps of Engineers,*
*Division Engineer, Northwest Division.*

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* Not printed.

### REPORT OF LIEUTENANT H. F. HODGES, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
*Cincinnati, Ohio, October 10, 1892.*

SIR: I have the honor to make the following report on the preliminary examination of the Little Miami River, with the view of forming an ice harbor. The examination was provided for in the river and harbor act of July 13, 1892, and was made by me under your orders on the 5th instant.

The little Miami River empties into the Ohio from its right bank 6 miles above Cincinnati. At low water it occupies a channel of about 50 feet in width between bars of clay and sand. The banks which define the high-water channel are high and about 200 feet apart. They rise steeply from the clay bars at the base. For some distance above and below the mouth a large bar of cemented gravel extends well out into the Ohio River narrowing the latter to about half its normal width. One mile above the mouth the Little Miami is crossed by two bridges, one carrying a highway, the other the roadway of the Cincinnati, Georgetown and Portsmouth Railroad. The highway bridge, which is the farther downstream, would limit the high-water navigation of the river. The appearance of the locality is indicated approximately by the accompanying sketch. At the time of the examination, when the Ohio was at $4\frac{7}{10}$ feet on the Cincinnati gauge, a channel 20 feet wide and 1 foot deep could not have been found into the Little Miami.

An ice harbor placed almost anywhere in this vicinity would be of great service to the commerce of the Ohio River, especially to the coal trade. To be an efficient and commodious shelter it should have a depth of 6 feet and a least width of 200 feet at all stages, since the ice has been known to go out at very low water.

The mouth of the Little Miami is not well adapted to the formation of such a harbor. The bars which occupy a large part of the high-water bed rise several feet above the low-water surface, and would not be drowned out until the water had risen to a comparatively high level. Before the necessary depth and width would be reached in the harbor the Ohio River would stand at about 16 feet on the Cincinnati gauge. A shelter available only at such high water would be of little or no use. The conditions being so unfavorable, I am compelled to report the locality as not worthy of improvement.

No survey is recommended.

Very respectfully, your obedient servant,

H. F. HODGES,
*First Lieutenant, Corps of Engineers.*

Maj. AMOS STICKNEY,
*Corps of Engineers, U. S. A.*

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## F F 19.

## PRELIMINARY EXAMINATION OF THE OHIO RIVER BETWEEN IRONTON, OHIO, AND THREE MILES ALONG AND UP THE OHIO EAST OF THE MOUTH OF GUYAN RIVER, WEST VIRGINIA.

[Printed in House Ex. Doc. No. 121, Fifty-second Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
*Washington, D. C., December 5, 1892.*

SIR: The river and harbor act approved July 13, 1892, provides for preliminary examination of Ohio River between Ironton, Ohio, and 3 miles along and up the Ohio east of the mouth of Guyan River, West Virginia, for the purpose of ascertaining what is necessary to clear said river between said points of obstructions and to deepen the channel thereof where necessary, with all such other improvements as may be found expedient for the storing and harboring of steamboats, coal barges, and for the landing and shipping of coal and other freights on said river between said points.

This examination was assigned to the charge of Maj. Amos Stickney, Corps of Engineers, and I have now the honor to submit the accompanying copy of report dated September 3, 1892, by that officer comply with the terms of the act.

Major Stickney states that this locality is, in his opinion, eminently worthy of such improvement by the General Government as can be made at reasonable cost, and his opinion is concurred in by the division engineer and by this office. The survey necessary for preparing and submitting plans for improvement will, it is estimated, cost $2,5

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
*Brig. Gen., Chief of Engineers.*

Hon. S. B. ELKINS,
*Secretary of War.*

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## REPORT OF MAJ. AMOS STICKNEY, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
*Cincinnati, Ohio, September 3, 1892.*

GENERAL: I have the honor to submit the following report on the preliminary examination of the Ohio River between Ironton, Ohio, and 3 miles along and up the Ohio, east of the mouth of Guyan River, West Virginia, for the purpose of ascertaining what is necessary to clear said river between said points of obstructions, and to deepen the channel thereof where necessary, with all such other improvements as may be found expedient for the storing and harboring of steamboats, coal barges, and for the landing and shipping of coal and other freights on said river between said points. This examination was assigned to my charge by letter of the Chief of Engineers, U. S. Army, dated July 14, 1892, and was made by my assistant, First Lieut. Harry F. Hodges, Corps of Engineers, U. S. Army, a copy of whose report is transmitted herewith.

The reach of river between Ironton, Ohio, and a point 3 miles above the mouth of the Guyan River, is about 25 miles in length, and the principal obstructions to navigation are a number of bars composed mostly of sand and gravel, that at the mouth of the Guyan River being one of the worst upon this part of the Ohio River, and causing at this time a suspension of navigation for boats coming from below. Upon this reach of river are located a number of thriving cities and towns which are largely engaged in manufacturing and shipping. The principal cities are Ironton, Ohio; Ashland and Catlettsburg, Ky.; Huntington and Guyandotte, W. Va. The removal of obstructions to navigation in this reach is a matter of particular importance to these cities, and it is a matter of general importance to a large part of the entire commerce of the river which passes this locality. The appropriations which have been made by Congress for the improvement of the Ohio River have been expended upon a length of 966 miles. It has therefore been impossible, with the small amount provided per mile of river, to make or to attempt thorough improvements of all localities.

There can be no question that this particular locality is an important part of the river, and should receive as much attention as it is possible to give it. It has been suggested that the improvement should be made by the construction of a lock and movable dam similar to that now in operation at Davis Island, 5 miles below Pittsburg, in order that a deep pool may be formed for the harboring of steamboats and coal boats. Such an improvement would cost somewhere in the neighborhood of $1,000,000, and, while forming a harbor, would not improve the general navigation of the river except for a comparatively short reach, which would be cut off during low-water stages from deep-water communication with the river above and below, until deep water was extended by similar works above and below. The system of improvement by locks and movable dams inaugurated on the upper part of the Ohio River has apparently been determined upon by the national Congress only to a point about 30 miles below Pittsburg. In this distance six dams are required to obtain a minimum depth of 6 feet in low water. Ironton is 325 miles from Pittsburg, and while the slope of the river is much less at the former point than in the upper part of the river, and permissible length of pools would be greater, it is manifest that a great many dams would be needed to carry the system through so that it should be continuous from Pittsburg to Ironton, or in the other direction from Ironton to Cincinnati, a distance of 142 miles.

It is highly probable that all requisite improvements of channel as far as present commerce demands, and which will be beneficial to through as well as local commerce, can be made at a very much less cost than by the construction of a lock and dam, and the locality is eminently worthy of such improvement by the General Government as can be made at reasonable cost. To form plans and estimates for necessary work will require a survey which is estimated to cost $2,500.

Very respectfully, your obedient servant,

AMOS STICKNEY,
*Major of Engineers.*

Brig. Gen. THOMAS L. CASEY,
*Chief of Engineers, U. S. A.*

(Through Col. O. M. Poe, Corps of Engineers, Division Engineer, Northwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
*Detroit, Mich., ——, 1892.*

Respectfully forwarded to the office of the Chief of Engineers.

Upon the information given by the district engineer I am of opinion that the locality is worthy of improvement by the General Government, in the manner indicated by him, and approve his estimate of the cost of the necessary surveys involved.

O. M. POE,
*Colonel, Corps of Engineers,*
*Division Engineer, Northwest Division.*

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## REPORT OF LIEUT. HARRY F. HODGES, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
*Cincinnati, Ohio, September 1, 1892.*

SIR: I have the honor to make the following report upon the preliminary examination of the Ohio River, from Ironton, Ohio, to a point 3 miles above the mouth of the Guyan River, West Virginia.

The distance along the river between the points named is 25 miles. In this stretch the river is obstructed by bars and shallows as follows, viz:

Ashland Bar (Pogue Shallows), extending from about 1 mile above Ironton to the Ashland furnaces.

Big Sandy Shallows, extending from about 1 mile below Catlettsburg to the Kenova bridge.

Twelve Pole Bar, extending from 1 mile below Burlington to the town.

Guyan Bar, below the mouth of the Guyan River.
Dogham Bar, about 3 miles above the same point.

In addition there are two or three snags near the channel, and a large number near the water line. The latter are complained of as obstructions to landing.

The Guyan Bar is said to be the worst one to be found for a long distance on the river. Any improvement in this locality would benefit both the through river traffic and the local commerce. The latter is large in the items of iron, coal, and lumber. The present examination was asked with a view to increasing the depth on the shallows named, and to carrying out such further improvements as should make this reach of the river suitable at all seasons for the shipment of coal. The construction of a movable dam to pond the river above Ironton seems to be what is desired to effect the latter object.

A dam at this place would either stand by itself, without relation to the general improvement of the river, or would require the extension of the slack-water system much further than has yet been contemplated. Without entering upon this question, it may be found practicable to improve the channel by much less costly operations. Of such improvement the locality is undoubtedly worthy. I would therefore recommend a survey of the river from Ironton to a point 3 miles above the mouth of the Guyan River; the estimated cost of such survey is $2,500.

Very respectfully, your obedient servant,

HARRY F. HODGES,
*First Lieutenant of Engineers.*

Maj. AMOS STICKNEY,
*Corps of Engineers, U. S. A.*

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## F F 20

## PRELIMINARY EXAMINATION OF RACCOON RIVER, OHIO, FROM ITS JUNCTION WITH THE OHIO RIVER FOR 50 MILES OF SAID RACCOON RIVER.

[Printed in House Ex. Doc. No. 116, Fifty-second Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
*Washington, D. C., December 5, 1892.*

SIR: I have the honor to submit herewith the accompanying copy of report of September 2, 1892, by Maj. Amos Stickney, Corps of Engineers, of the results of the preliminary examination of Raccoon River, Ohio, from its junction with the Ohio River for 50 miles of said Raccoon River, provided for by the river and harbor act approved July 13, 1892.

The Raccoon River is reported by Major Stickney to be, in his opinion, not worthy of improvement by the General Government, and his opinion is concurred in by the division engineer and by this office.

Very respectfully, your obedient servant,

THOS LINCOLN CASEY,
*Brig. Gen., Chief of Engineers.*

HON. S. B. ELKINS,
*Secretary of War.*

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### REPORT OF MAJ. AMOS STICKNEY, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
*Cincinnati, Ohio, September 2, 1892.*

GENERAL: I have the honor to submit the following report upon the preliminary examination of Raccoon River, Ohio, from its junction with the Ohio River for 50 miles of said Raccoon River, assigned to my charge by letter of the Chief of Engineers, U. S. Army, dated July 14,

1892. The examination was made by my assistant, First Lieut. Harry F. Hodges, Corps of Engineers, U. S. Army, a copy of whose report is transmitted herewith. The Raccoon River is a small stream that empties into the Ohio River just below Gallipolis, Ohio. It has a steep slope, which averages nearly 1½ feet to the mile. There is no navigation of any kind upon the river at present, though some years ago flatboats, loaded with iron from two furnaces, and timber rafts were floated down during high water.

The fall of the water is now utilized at several dams to furnish power for mills that produce flour and lumber, of which there are ten in the 54 miles of river above the mouth. The maximum capacity of the flour mills is but 50 barrels per twenty-four hours. There is said to be considerable undeveloped mineral wealth in the neighboring country. Some veins of coal have been found, but not worked to any extent. The object of the examination, it is learned, was to ascertain the feasibility of establishing slack-water navigation. From the examination it would appear that there would be no very great difficulty in building locks and dams, and the water supply would probably be sufficient for providing a navigable channel of 3 feet depth, but the cost of such an improvement would be excessive in comparison with the amount of commerce that might be developed. Lieutenant Hodges states that the improvement would require the building of twelve locks and dams, the clearing of the channel, and the payment for damages to mill property. * * *

In view of the above facts I must concur in the opinion of Lieutenant Hodges that the locality is not worthy of improvement by the General Government.

Very respectfully, your obedient servant,

AMOS STICKNEY,
*Major of Engineers.*

Brig. Gen. THOMAS L. CASEY,
*Chief of Engineers, U. S. A.*

(Through Col. O. M. Poe, Corps of Engineers, Division Engineer, Northwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
*Detroit, Mich., September 10, 1892.*

Respectfully forwarded to the office of the Chief of Engineers.

I concur in the opinion of the district engineer that Raccoon River, Ohio, is not worthy of improvement by the General Government.

O. M. POE,
*Colonel, Corps of Engineers,*
*Division Engineer, Northwest Division.*

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## REPORT OF LIEUT. HARRY F. HODGES, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
*Cincinnati, Ohio, September 2, 1892.*

SIR: I have the honor to make the following report on the preliminary examination of Raccoon River, Ohio:

The Raccoon River, or creek, rises in the southern part of Hocking County, Ohio, and flows in a tortuous but generaly southerly course through Vinton and Gallia counties, emptying into the Ohio River 6 miles below Gallipolis, Ohio. Its total length is about 110 miles. The principal tributary is the Little Raccoon, flowing in from the west at a point 39 miles from the mouth. The main creek furnishes power for a number of mills.

The Baltimore and Ohio Railroad crosses it twice in the upper part of its course. The Hocking Valley Railroad strikes it at Hawkes Station, 54 miles from the mouth, and follows it for about 13 miles to Vinton. From Vinton to the mouth of the creek the farmers and millers have no outlet for their produce except the wagon roads, which are very bad in the wet season.

The stream flows through a fertile bottom about 1 mile wide. The neighboring country is said to possess great undeveloped mineral wealth. At Adamsville, 28 miles from the mouth, two seams of coal were found while boring for oil. They are said to be 4 and 8 feet thick, and to lie at a depth of 40 and 83 feet, respectively. Near the mouth of the creek a 3-foot vein crops out of the hillsides at a much greater elevation, and is worked to a small extent for local use. A stream of natural gas and a spring of brine are now flowing from the old boring at Adamsville.

Forty or fifty years ago there was a considerable commerce on the creek. The Keystone and Buckeye furnaces sent their iron on flatboats down the Little and Big Raccoon and over the mill dams at high water. Timber rafts were also taken down in some quantities. There has never been any upstream navigation. At present there is no water traffic of any kind.

About twenty years ago a company was formed to improve the stream by a system of locks and dams. After doing a little preliminary work the company collapsed without building any locks. The present examination was asked with a view to establishing slack-water navigation for the lower 50 miles.

Hawkes Station, where the Hocking Valley Railroad strikes the stream, is 4 miles above the 50-mile point. As there is a good mill with the roller process at this place, it was probably intended to include it in the examination. Between there and the mouth of the creek there are ten mills, having an average fall of 5¼ feet. They produce flour and lumber. At Vinton there is a wool factory as an adjunct to the mill. Two of the flour mills use the roller process, the remainder the stone process. All use turbines or the old wooden tub wheels. The maximum capacity is 50 barrels in twenty-four hours. The dams divide the creek into a series of ponds, the consecutive ones being separated by short reaches of flowing stream. In some cases the lower dam backs the water entirely to the one above. The banks of the pools are usually very steep and have a minimum height of about 8 feet above water. The width is very uniform, being 75 to 50 feet above Little Raccoon and 125 to 100 feet below, except for a short distance at the mouth. A channel of 3 feet in depth could readily be obtained through these pools with a small amount of clearing. At Davis Dam, 23 miles from the Ohio, there is a rocky ledge which causes a fall of about 5 feet. There are other less important rapids at various points which would offer only slight obstacles to navigation by slack water.

Below the lowest mill there is a stretch of about 5 miles to the mouth, in which the stream has its natural flow, modified only by the remains of an old dam. In this reach it is rapid, narrow, and much obstructed by snags. It makes a sudden bend before emptying into the Ohio, and at its mouth is about 40 feet wide at low water. The discharge is ample to supply locks. There is nothing in the conditions to render the establishment of slack water difficult.

Estimating from the heights of the dams and the length of the backwater, the fall in the lower 50 miles is found to be 71 feet to the stage of the Ohio at the time of the examination, when it showed 2.6 feet on the Gallipolis gauge. To overcome this would require, say, twelve locks of 6 feet lift.

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The condition of the stream below the lowest dam, *i. e.*, from the mouth to Yellowtown, indicates that nothing but slack-water navigation will be of material benefit.

In view of the fact that there is no commerce on the river at present, it would not seem judicious to spend so large an amount to create a possible one. I must therefore report the locality as not worthy of improvement.

No survey is recommended.

Very respectfully, your obedient servant,

HARRY F. HODGES,
*First Lieutenant of Engineers.*

Maj. AMOS STICKNEY,
*Corps of Engineers, U. S. A.*

## F F 21.

## PRELIMINARY EXAMINATION FOR THE LOCATION OF THE NECESSARY NUMBER OF MOVABLE LOCKS AND DAMS ON THE OHIO RIVER BETWEEN DAVIS ISLAND DAM AND THE DAM AT OR NEAR THE MOUTH OF THE BEAVER RIVER, IN PENNSYLVANIA.

[Printed in House Ex. Doc. No. 45, Fifty-second Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
*Washington, D. C., December 5, 1892.*

SIR: I have the honor to submit the accompanying copy of report dated October 4, 1892, by Maj. Amos Stickney, Corps of Engineers, of the results of preliminary examination for the location of the necessary number of movable locks and dams on the Ohio River between Davis Island Dam and the dams at or near the mouth of the Beaver River, in Pennsylvania, made to comply with provisions of the river and harbor act approved July 13, 1892.

I concur in the opinion of the local and division engineers, that this portion of the Ohio River is worthy of improvement by the General Government.

Major Stickney submits an estimate of $2,800 as the cost of the surveys necessary to the preparation of plan and project, with estimate of the improvement proposed.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
*Brig. Gen., Chief of Engineers.*

Hon. S. B. ELKINS,
*Secretary of War.*

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### REPORT OF MAJ. AMOS STICKNEY, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
*Cincinnati, Ohio, October 4, 1892.*

GENERAL: I have the honor to submit the following report upon a preliminary examination for the location of the necessary number of movable locks and dams on the Ohio River between Davis Island Dam and the dam at or near the mouth of the Beaver River, in Pennsylvania, assigned to my charge by letter from your office dated July 14, 1892. The examination was made by my assistant, Lieut. Harry F. Hodges, Corps of Engineers, a copy of whose report is transmitted herewith. The approximate locations of the necessary locks and dams for continuing the system of slack-water navigation inaugurated by the construction of the lock and dam at Davis Island were selected by the late Lieut. Col. William E. Merrill, Corps of Engineers, with whom this method of improving the navigation of the upper part of the Ohio River originated. This matter received careful attention from Colonel Merrill and it is believed that the locations are well selected.

It is proper and necessary, however, before commencing the construction of such important and costly structures to obtain definite information, which requires a careful survey at the site of each proposed work. By the location of a lock and dam below the mouth of Beaver River, the construction of which has been commenced, it is pretty definitely settled that four additional locks and dams will be required to complete the system from Pittsburg to the lock below Beaver River, a distance of about 30 miles. The number of dams was fixed by the maximum lift which it was deemed advisable to give to any dam. The system of improvement of the navigation of this part of the river by locks and dams was determined upon on account of the steep slope and small supply of water, and also on account of the harbor facilities that would be afforded by the pools for holding large numbers of boats loaded with coal that could take advantage of small rises to start on their way downstream. The dams are made movable in order that they may be thrown down and leave an unimpeded channel for the quick passage of the large fleets of coal boats. That this part of the river is worthy of improvement by the General Government is a question that does not admit of a doubt, since a large part of its great commerce originates in the adjacent coal mines of the Monongahela River and the immense manufacturing establishments of Pittsburg and vicinity. The necessary survey for the location of Lock and Dam No. 2 has already been provided for by Congressional act. The surveys for other locations are estimated to cost $2,800.

Very respectfully, your obedient servant,

AMOS STICKNEY,
*Major of Engineers.*

Brig. Gen. THOMAS L. CASEY,
*Chief of Engineers, U. S. A.*

(Through Col. O. M. Poe, Corps of Engineers, Division Engineer, Northwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
*Detroit, Mich., October 6, 1892.*

Respectfully forwarded to the office of the Chief of Engineers.

I concur in the opinion of the district engineer, as herein expressed.

O. M. POE,
*Colonel, Corps of Engineers,*
*Division Engineer, Northwest Division.*

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### REPORT OF LIEUT. HARRY F. HODGES, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
*Cincinnati, Ohio, September 19, 1892.*

SIR: I have the honor to make the following report of the preliminary examination for the necessary number of "movable locks and dams" on the Ohio River between Davis Island Dam and the dams at or near the mouth of the Beaver River, in Pennsylvania. This examination was ordered by the river and harbor act of July 13, 1892.

A Board of Engineers, the report of which will be found on pages 1869 *et seq.* of the Annual Report of the Chief of Engineers for 1889, has already stated that it is "practicable, feasible, and advisable to improve the Ohio River from Pittsburg to a point just below the mouth of the Beaver River * * * by the construction of movable dams."

The United States has already entered upon the construction of a movable dam near Beaver, Pa., which will form the sixth of the series necessary to pool the river to this point. The present examination is for the purpose of locating the four dams intermediate between the Beaver Dam and the Davis Island Dam.

The reasons given for the recommendations of the board referred to above, as well as the statistics of the commerce passing Davis Island Dam, published annually in the Report of the Chief of Engineers, sufficiently show that the locality is worthy of improvement.

The approximate location of the dams now in question was fixed as follows in the report of the Board of Engineers already cited:

No. 1. Davis Island Dam; lift, 7 feet. Five and one-half miles from origin of profile.

No. 2. At Merrimans Bar; lift, 7 feet. Ten miles from origin.

No. 3. At the Trap; lift, 7 feet. Eleven and three-quarters miles from origin.

No. 4. At Logstown Bar; lift, 7 feet. Eighteen and three-quarters miles from origin.

No. 5. Just below Beaver River; lift, 7 feet. Twenty-six miles from origin.

No. 6. Not located. Indicated by profile as having lift of 7 feet, and placed at Raccoon Creek, 31 miles from origin.

It should be noted that the origin of the distances on the profile differs from that on the published map of the Ohio River, being almost a mile farther upstream; thus, 31 miles on the profile corresponds to 30 on the published map, very nearly.

At the time when the location was fixed for the dam now under construction near Beaver, which, to comply with the wishes of the navigators, was forced so far downstream as to become Dam No. 6 of the series, instead of Dam No., 5, Col. Merrill, on April 23, 1891, prepared a tabular statement of the heights and dimensions of the four intermediate dams, and located them on a profile, a copy of which accompanies this report. The heights, lifts, and locations recommended by him were as follows:

| Number. | Height of wickets. | Lift. | Location. |
|---|---|---|---|
| | *Feet.* | *Feet.* | |
| 1 | 12.125 | 6.125 | Davis Island (constructed), 5¼ miles from origin. |
| 2 | 13.741 | 7.741 | Head of Merrimans Bar, 10¾ miles from origin. |
| 3 | 13.741 | 7.741 | Below the Trap, 12 1/16 miles from origin. |
| 4 | 13.641 | 7.641 | Below Logstown Bar, 19⅝ miles from origin. |
| 5 | 10.726 | 4.726 | Below Lacocks Bar, 25 miles from origin. |
| 6 | 13.155 | 7.155 | Below Raccoon Rapids, 30¾ miles from origin. |

The distances given above are measured on the profile and are nearly 1 mile greater than when measured from the origin of the printed map. Col. Merrill contemplated the possibility of moving Dam No. 4 farther upstream, to the foot of Deadmans Bar, and drowning the rapids at Logstown by Dam No. 5, but fixed on the location as given above. There seems to be no reason for deviating from the approximate positions mentioned by him. There is always a sufficient margin in placing a dam to allow a proper weight to be given to local considerations of foundation, etc. Accepting the above positions as approximately accurate, I would recommend that instrumental surveys, with soundings and borings, be made for stretches of one-half mile in length below each of the following localities:

Head of Merrimans Bar; foot of the Trap; foot of Deadmans Island; foot of Logstown Bar; foot of Lacocks Bar; and that the definite positions of the dams be determined by the results of the surveys, Dam No. 4 being placed either below Deadmans Island or below Logstown Bar. The estimated cost of the surveys is $3,500.

Very respectfully, your obedient servant,

Harry F. Hodges,
*First Lieutenant, Corps of Engineers.*

Maj. Amos Stickney,
*Corps of Engineers, U. S. A.*

## FF 22.

## PRELIMINARY EXAMINATION FOR LOCK AND DAM AT THE MOST PRACTICABLE POINT FOR NAVIGATION ON ALLEGHENY RIVER, BETWEEN THE DAM AT TARENTUM AND HERR ISLAND DAM, PENNSYLVANIA.

[Printed in House Ex. Doc. No. 87, Fifty-second Congress, second session.]

Office of the Chief of Engineers,
United States Army,
*Washington, D. C., December 5, 1892.*

Sir: I have the honor to submit the accompanying copy of report, dated October 3, 1892, by Maj. Amos Stickney, Corps of Engineers, of the results of a preliminary examination for lock and dam at the most practicable point for navigation on Allegheny River, Pennsylvania, between the dam at Tarentum and Herr Island Dam.

It is the opinion of Major Stickney, concurred in by the division engineer and by this office, that the Allegheny River within the limits mentioned is worthy of improvement by the General Government.

In the judgment of the local engineer, $2,000 will be required for the surveys necessary to the preparation of plan and project with estimate of cost of improvement proposed.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
*Brig. Gen., Chief of Engineers.*

Hon. S. B. ELKINS,
*Secretary of War.*

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### REPORT OF MAJ. AMOS STICKNEY, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
*Cincinnati, Ohio, October 3, 1892.*

GENERAL: I have the honor to submit the following report upon a preliminary examination for lock and dam at the most practicable point for navigation on Allegheny River, between the dam at Tarentum and Herr Island Dam, Pennsylvania. The examination was made by my assistant, Lieut. Harry F. Hodges, Corps of Engineers, a copy of whose report is transmitted herewith.

From the phraseology of the act of Congress directing this examination to be made, it would seem that it was the expectation of Congress to continue the system of slack-water navigation on the Allegheny River from Herr Island to or above the town of Tarentum, Pa., and that for this purpose but two locks and dams would be required, one at or near Tarentum, and one intermediate at some point between the dam at Tarentum and Herr Island.

From investigation of the subject it would seem to be desirable to build two locks and dams between the points mentioned. The reason for this, as stated in the report of Lieutenant Hodges, is that the difference in level of the contemplated pool of Herr Island Dam and the natural water surface at Tarentum is 22 feet, and if the Tarentum Dam is placed within 5 miles of that town it would be necessary to build a dam with a lift of 15 feet to carry a 6-foot channel from the Herr Island Pool to the Tarentum Dam. It is thought that such a high dam would have considerable effect upon the flood levels of the river, that serious damage might result and that it would be judicious to overcome the difference in level by two dams between the Tarentum Dam and Herr Island Dam. This matter can be more intelligently discussed after a proper survey of the locality. Villages and factories on the banks of this part of the river form almost a continuous line, and the extension of the slack-water sytem of navigation from the mouth of the Allegheny to Tarentum would not only provide an outlet for the products of the numerous manufacturing establishments, but would make commodious harbors.

I think there is no question about the worthiness of the improvement by the General Government. The survey necessary for determining plans and cost of works is estimated to cost $2,000.

Very respectfully, your obedient servant,

AMOS STICKNEY,
*Major of Engineers.*

Brig. Gen. THOMAS L. CASEY,
*Chief of Engineers, U. S. A.*

(Through Col. O. M. Poe, Corps of Engineers, Division Engineer, Northwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
*Detroit, Mich., October 6, 1892.*

Respectfully forwarded to the office of the Chief of Engineers.

I concur in the opinion of the district engineer that the extension of the slack-water system of navigation from the mouth of Allegheny River to Tarentum is worthy of improvement by the General Government.

O. M. POE,
*Colonel, Corps of Engineers,*
*Division Engineer, Northwest Division.*

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### REPORT OF LIEUT. HARRY F. HODGES, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
*Cincinnati, Ohio, September 19, 1892.*

SIR: I have the honor to make the following report of the preliminary examination for a lock and dam at the most practicable point for navigation on Allegheny River, between the dam at Tarentum and Herr Island Dam. The examination was ordered by the river and harbor act of July 13, 1892.

The distance by the river from the town of Tarentum to the Herr Island Dam is 20.4 miles Along this part the river is followed by the West Pennsylvania Railroad on the right bank and by the Allegheny Valley Railroad on the left bank. The villages and factories are so numerous as to form almost a continuous line along the stream.

Statistics of the commerce of the Allegheny River will be found in the Annual Report of the Chief of Engineers for 1890, p. 2195. These statistics are criticised by Col. Merrill, in whose report they are found, as being incomplete and not representing the full volume of trade. It is highly probable that all the more bulky supplies and products of the factories would be transported by water, were the river available at all times, and that the estimate of the river commerce referred to above would fall far short of the reality. The immense interests involved would seem to warrant any improvement by which the trade of Pittsburg and Allegheny City may be furthered.

Between Tarentum and the level of the Herr Island Dam pool as it will be when the work is completed, the natural surface of the stream falls about 22 feet. This difference in level is probably not accurate, as it is taken from a reconnaissance which was made in 1828; but the data are sufficient for the present purpose.

A depth of 6 feet is assumed to be necessary for navigation. This depth will be assured by the proposed Herr Island Dam for a distance of about 4.3 miles to the foot of Six-Mile Rapids. At this place the required depth runs out; a second dam must therefore be placed here to pool the water in the stretch above. The wording of the act, taken in connection with that calling for the location of a dam at or near Tarentum, indicates that but one dam is contemplated to pool the water between Herr Island and the Tarentum Dam. To obtain the navigable depth at Tarentum will require raising the natural surface there about 3 feet. There is, therefore, a lift of 25 feet above the Herr Island Pool, which must be overcome by a dam at the foot of Six-Mile Rapids and one "at or near Tarentum."

The fall is not uniformly distributed over the length of the stream. It occurs chiefly at the points where islands obstruct the flow. The river is thus divided into reaches in which the slope is slight and which are separated by comparatively short rapids of much greater slope. The principal rapids, beginning at the Herr Island Pool, are Six-Mile Rapids, Nine-Mile Rapids, rapids at the foot of Fourteen-Mile Island, Poketo Ripple, and Lockharts Ripple, near Creighton Station.

Calling the Herr Island Dam No. 1, the one at the foot of Six-Mile Rapids becomes No. 2. If Dam No. 2 be required to pool the water to a point at or near Tarentum it must have a lift of about 15 feet. This would carry the navigable depth to a point near the foot of Poketo Ripple, 5 miles below Tarentum. Dam No. 3, at this point, with a lift of 10 feet, would give a depth of 6 feet over the head of Lockharts Ripple and into the nearly level reach opposite Tarentum. If Dam No. 2 were built of a height less than 15 feet the navigable depth would run out, not at Poketo Ripple, but at the foot of the rapids next below, viz, at Fourteen-Mile Island, 5 miles farther down stream and 10 miles below Tarentum. Since the stretch between Poketo and Fourteen-Mile Island is nearly level, it would require but a slight lowering of the crest of Dam No. 2 to force Dam No. 3, 5 miles farther downstream, and to thus prevent it from being a dam "at or near Tarentum." To place Dam No. 3 where the act requires it, necessitates therefore a lift of 15 feet for Dam No. 2, if but two dams are used. The effect of such a lift upon the flood waters of the river would very probably cause serious damage to the surrounding country.

It would seem much safer to pool the water between the Tarentum Dam and the Herr Island Dam by two intermediate dams, rather than by one. The first of these falls, of course, at the foot of Six-Mile Rapids, where the Herr Island Pool runs out. Dam No. 2, at this place, should have a lift of 6 feet to give the navigable depth to the foot of Nine-Mile Rapids next above. It would be possible to overcome the fall at Nine-Mile Rapids and to pool the water to Fourteen-Mile Island by Dam No. 2, but to do this would require a lift of 12½ feet. It seems better to put Dam No. 3 at the foot of Nine-Mile Rapids rather than to place it farther upstream and to exaggerate the height of No. 2.

Dam No. 3, at the foot of Nine-Mile Rapids, will pool the water to the navigable depth as far as the foot of Lockharts Ripple, opposite Creighton Station. Dam No. 4, at the foot of Lockharts Ripple, will give the navigable depth beyond Tarentum with a reasonable lift.

If the establishment of slack water to Tarentum be undertaken, I would recommend that the locks and dams be located approximately as follows:

Dam No. 2, lift 6 feet, at or near the station of Sharpsburg, below Six-Mile Rapids and 4.3 miles above Herr Island Dam.

Dam No. 3, lift 10 feet, at or near Claremont Station, below Nine-Mile Rapids and 3.8 miles above No. 2.

Dam No. 4, lift 10 feet, at or near Creighton Station, below Lockharts Ripple, and 2 miles below Tarentum. This dam has been made the subject of a separate report on the location of a dam "at or near Tarentum."

These lifts and distances are based upon a simple reconnaissance, and are subject to the changes which a more accurate survey shall indicate as necessary.

As the locality seems worthy of improvement, I would further recommend that the line of levels run by Mr. J. W. Arras, assistant engineer, for 11 miles up the river, be extended to embrace all the localities mentioned as sites for dams; that an instrumental survey be made extending from Herr Island Dam to a point 6 miles above Tarentum; and that soundings and borings be made for a distance of one-half a mile below Six-Mile Rapids and Nine-Mile Rapids, to determine with accuracy the best site for the two intermediate dams.

The estimated cost of this work is $2,000.

Very respectfully, your obedient servant,

HARRY F. HODGES,
*First Lieut., Corps of Engineers.*

Maj. AMOS. STICKNEY,
*Corps of Engineers.*

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## F F 23.

## PRELIMINARY EXAMINATION FOR LOCK AND DAM ON ALLEGHENY RIVER AT OR NEAR TARENTUM, PA.

[Printed in House Ex. Doc. No. 37, Fifty-second Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
*Washington, D. C., December 5, 1892.*

SIR: I have the honor to submit the inclosed copy of report, dated October 3, 1892, by Maj. Amos Stickney, Corps of Engineers, of the results of a preliminary examination for lock and dam on Allegheny River, at or near Tarentum, Pa., made under his direction, to comply with provisions of the river and harbor act approved July 13, 1892.

Major Stickney is of opinion that the river at this point is worthy of improvement by the General Government, not only for the benefit of the immediate locality, but as a part of the system of slack-water navigation on the lower part of the river, and that $500 will be required to make survey necessary to the preparation of plan and project, with estimate of cost of improvement proposed.

His opinion is concurred in by the division engineer and by this office.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
*Brig. Gen., Chief of Engineers.*

Hon. S. B. ELKINS,
*Secretary of War.*

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### REPORT OF MAJ. AMOS STICKNEY, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
*Cincinnati, Ohio, October 3, 1892.*

GENERAL: I have the honor to submit the following report upon a preliminary examination for lock and dam on Allegheny River, at or near Tarentum, Pa., assigned to my charge by letter from your office dated July 14, 1892. The examination was made by my assistant, Lieut. Harry F. Hodges, Corps of Engineers, a copy of whose report is transmitted herewith. The town of Tarentum is about 21 miles above the city of Allegheny. The surface of the river is 32 feet above the natural surface at the site of Herr Island Dam. This dam will raise the water surface about 10 feet, so there will be a difference of level between Herr Island and Tarentum of about 22 feet.

From reconnoissances and levelings that have been made, it seems probable that two dams will be needed to carry a 6-foot channel up to Creighton, about 2 miles below Tarentum, and that in continuation of a slack-water channel a dam should be placed at or near Creighton, which would form a pool extending above Tarentum. The location for such a dam can not be definitely fixed without a survey. The banks of the Allegheny River are built up for almost the entire distance from Pittsburg to Tarentum, and there are many manufacturing establishments located here whose products would go to swell the commerce of the river if it were made navigable at all stages. The river at this point is deemed to be eminently worthy of improvement not only for the benefit of the immediate locality, but as a part of the system of slack-water navigation on the lower part of the river. It is estimated to cost $500 to make a survey with the view of submitting plan and estimate for the lock and dam.

Very respectfully, your obedient servant,

AMOS STICKNEY,
*Major of Engineers.*

Brig. Gen. THOMAS L. CASEY,
*Chief of Engineers, U. S. A.*

(Through Col. O. M. Poe, Corps of Engineers, Division Engineer, Northwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
*Detroit, Mich., October 6, 1892.*

Respectfully forwarded to the office of the Chief of Engineers.

I concur in the opinion of the district engineer, as herein expressed.

O. M. POE,
*Colonel, Corps of Engineers,*
*Division Engineer, Northwest Division.*

## REPORT OF LIEUT. HARRY F. HODGES, CORPS OF ENGINEERS.

U. S. ENGINEER OFFICE,
*Cincinnati, Ohio, September 17, 1892.*

SIR: I have the honor to make the following report of the preliminary examination for a lock and dam on the Allegheny River, at or near Tarentum, which was ordered by the river and harbor act of July 13, 1892.

The town of Tarentum lies on the Allegheny River, 21 miles above the city of Allegheny. Two railroads, the Allegheny Valley Railroad on the left bank and the West Pennsylvania Railroad on the right bank, follow the stream to points beyond the town. The outlying suburbs of Pittsburg and Allegheny City, and the separate villages on the banks, form a nearly continuous line, skirting the river as far as Tarentum. The accommodation trains on the West Pennsylvania Railroad have twenty-five stations in this reach of the stream.

A great number of industrial establishments of various kinds are located along the river for many miles, and contribute their share to the great commerce of Pittsburg and Allegheny City. Statistics of the trade of the river are given in the Annual Report of the Chief of Engineers for 1890, p. 2195. There can be no question that all of the cheaper and more bulky supplies and products of the factories would choose the river transportation, were it available.

As sources of information in regard to the topographical features of this portion of the stream, there are at hand reconnoissances made by Lieuts. Graham and Berrien, in 1828, and by Lieut. F. A. Mahan, Corps of Engineers, in 1874; and a line of levels run over the lower 11 miles of the stream by Mr. J. W. Arras, assistant engineer, in 1884. From these data, it appears that the water surface at Tarentum is 32 feet above the natural surface at the Herr Island Dam. The establishment of the Davis Island Dam and the Herr Island Dam will raise the water's surface in the pool of the latter 10 feet above the natural surface at that point. There will remain 22 feet of fall to be overcome. If the crest of the Herr Island Dam be placed at a level of 6 feet above the surface of the pool of the Davis Island Dam when full, a depth of 6 feet will be secured as far as the foot of Six Mile Rapids, about 4.3 miles above.

A fixed dam here with a lift of 6 feet would carry the depth of 6 feet to the foot of Nine Mile Rapids, or about 3.8 miles farther up. A fixed dam near the foot of Nine Mile Island with a lift of 10 feet will carry the required depth of 6 feet as far as Creighton, about 2 miles below Tarentum. A fixed dam, numbered 4 of the series, placed at Creighton will give a pool extending above Tarentum for a distance proportional to the lift. A 10-foot lift will give a depth of 6 feet for about 6 miles above Tarentum. The dam at Creighton, or Dam No. 4, is therefore the one to be located by this preliminary examination. Its position within a few hundred yards can be determined as above from the approximate differences in level as given by the reconnoissances already referred to. To fix the location exactly requires a more detailed knowledge of the foundations than can be obtained by a simple examination, as well as a more accurate line of levels than those at hand to cover a stretch of about 10 miles below Tarentum.

As the locality is undoubtedly worthy of improvement, and as the location of a dam at this place is in line with a project for the establishment of slack water in the lower Allegheny, I would recommend that the levels run by Mr. Arras be extended to a point 6 miles above Tarentum, and that an accurate survey, with soundings and borings, be made of a stretch of the river one-half mile long below the old milldam at Creighton. The estimated cost of this work is $500.

Very respectfully, your obedient servant,

HARRY F. HODGES,
*First Lieut. of Engineers.*

Maj. AMOS STICKNEY,
*Corps of Engineers, U. S. A.*

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## F F 24.

## PRELIMINARY EXAMINATION OF ALLEGHENY RIVER FROM OLEAN, N. Y., TO WARREN, PA.

[Printed in House Ex. Doc. No. 61, Fifty-second Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
*Washington, D. C., December 5, 1892.*

SIR: I have the honor to submit the accompanying copy of report, dated September 30, 1892, by Maj. Amos Stickney, Corps of Engineers, of the results of a preliminary examination of Allegheny River from

Olean, N. Y., to Warren, Pa., made to comply with provisions of the river and harbor act approved July 13, 1892.

It is the opinion of Major Stickney, concurred in by the division engineer and by this office, that the river, within the limits named, is not worthy of improvement by the General Government.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
*Brig. Gen., Chief of Engineers.*

Hon. S. B. ELKINS,
*Secretary of War.*

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## REPORT OF MAJ. AMOS STICKNEY, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
*Cincinnati, Ohio, September 30, 1892.*

GENERAL: I have the honor to submit the following report upon the preliminary examination of the Allegheny River between Olean, N. Y., and Warren, Pa., assigned to my charge by letter from your office dated July 14, 1892.

The examination was made by my assistant, Lieut. Harry F. Hodges, Corps of Engineers, a copy of whose report is transmitted herewith.

The river between Olean and Warren is exceedingly shallow, with but a small amount of water passing, and has a steep slope, amounting in some places to 5 feet fall in 1 mile. For a portion of this distance the river is used to some extent for floating logs to mill, but regular rafting can not be carried on under a 4-foot stage. The only improvement of the river that could be of much benefit to the community would be by the construction of locks and dams to make slack-water navigation, and the great cost of such works in comparison with the commerce that might be benefited renders it inadvisable to undertake them. A survey was made of this part of the river by the United States, in 1880, and some work of improvement done to facilitate the rafting of logs, but it would seem that further work of this description is not called for. I concur in the opinion of Lieut. Hodges that the locality is not worthy of improvement by the General Government.

Very respectfully, your obedient servant,

AMOS STICKNEY,
*Major of Engineers.*

Brig. GEN. THOMAS L. CASEY,
*Chief of Engineers, U. S. A.*

(Through Col. O. M. Poe, Corps of Engineers, Division Engineer, Northwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
*Detroit, Mich., October 1, 1892.*

Respectfully forwarded to the office of the Chief of Engineers.

I concur in the opinion of the district engineer—that the river, within the limits indicated, is not worthy of improvement by the General Government.

O. M. POE,
*Colonel, Corps of Engineers,*
*Division Engineer, Northwest Division.*

## REPORT OF LIEUT. HARRY F. HODGES, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
*Cincinnati, Ohio, September 27, 1892.*

MAJOR: I have the honor to make the following report of the preliminary examination of the Allegheny River between Olean, N. Y., and Warren, Pa., which was ordered by the river and harbor act of July 13, 1892:

The distance between the points named, measured along the river, is 67 miles. The New York, Lake Erie and Western Railroad follows the stream for 23 miles from Olean to Salamanca; the Western New York and Pennsylvania Railroad follows it for the whole distance from Olean to Warren; the Buffalo, Rochester and Pittsburg Railroad and a line of the Erie Railroad from Bradford cross it 15 miles below Olean. It will therefore be seen that there is no lack of railway transportation.

In 1880 a survey was made by the United States of the Allegheny River from Olean, N. Y., to Franklin, Pa., a distance of 132 miles. By this survey it was found that the fall of the river's surface in the first 20 miles below Olean averages 1.7 feet per mile. In the second 20 miles the average fall is 3.7 feet per mile; in the third 20 miles the average fall is 5 feet per mile; while in the fourth and fifth stretches of 20 miles the average fall is 3.5 feet per mile.

Between Olean and Warren the river is shallow, tortuous, and much obstructed by ripples, remains of old dams and booms. There are dams still in use at Salamanca, Corydon, and Shipmans Island. The width of the river reaches 300 feet in places. At the time of the examination, when the water gauge at Warren indicated three-tenths of a foot, a skiff drawing 8 inches of water could not come down from Olean without repeatedly requiring to be dragged over the shallows. On many ripples the depth was not more than from 3 to 6 inches for distances of 100 feet or more.

The principal towns on this stretch of the river are Olean, Salamanca, Corydon, Kinzua, and Warren. The principal interests are in lumber, tanning, oil, and iron works.

At present the river between Olean and Carrollton, 17 miles below, is not used for any purposes of transportation. Below Carrollton it is used to some extent for floating the logs which are cut along the banks to the mills where they are worked up, the lumber being shipped by rail. For regular rafting a stage of 4 feet in the channel at Warren is said to be necessary; for drifting, much less would suffice.

Without the establishment of a system of locks and dams there seems no possibility of an improvement which should fit this part of the river for purposes of general commerce. Regarding such a system as out of the question for the present, the only thing which can be done is to so clear the channel as to permit rafting at lower stages. By such improvement the lumber and bark trades alone would be benefited.

A certain amount of work has already been done by the United States with this end in view. The worst bowlders and rocks have been removed from the channel and a log chute has been constructed over the dangerous dam at Corydon. In spite of this work, which resulted in making rafting much easier, the shipments of lumber on the river have diminished to practically nothing now, while in 1880, 28,000,000 feet, B. M., of sawed lumber are reported as the annual river trade between and including Olean and Warren. The lumbermen say that at present the sole use of the river is for rafting or drifting round timber for short distances from the places where it is felled to the mills.

An improvement might be effected in the river by diking or dredging in such manner as to remove the worst ripples and to make rafting easier. There seems to be but little demand for such improvement even among those interested in the lumber trade. Nearly all the business men who were consulted, both in Warren and Olean, gave it as their opinion that further expenditure on the river would be a waste of money. To accomplish radical improvement for a distance of only 15 miles above Warren, would require diking or dredging at seventeen places, the worst ones being at a ripple just above Conewango Creek, at Shipmans Island, and at Kinzua Island. For the rest of the way the stream is in about as bad a state. The result of any work would be to prolong by a few weeks the season of rafting, and would be of no help to general trade. I am of the opinion that the expense would be out of all proportion to the benefits to be derived, and that the locality is not worthy of further improvement by the United States.

A survey of the river between the points named has already been made. No further survey is recommended.

Very respectfully, your obedient servant,

HARRY F. HODGES,
*First Lieutenant, Corps of Engineers.*

Maj. AMOS STICKNEY,
*Corps of Engineers.*

# APPENDIX G G.

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## IMPROVEMENT OF FALLS OF OHIO RIVER, OF WABASH RIVER, INDIANA AND ILLINOIS, AND OF WHITE RIVER, INDIANA.

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### *REPORT OF LIEUT. COL. G. J. LYDECKER, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1893, WITH OTHER DOCUMENTS RELATING TO THE WORKS.*

IMPROVEMENTS.

1. **Falls of the Ohio River, at Louisville, Ky.**
2. **Indiana Chute, Falls of the Ohio River.**
3. **Operating and care of Louisville and Portland Canal, Kentucky.**
4. **Wabash River, Indiana and Illinois.**
5. **White River, Indiana.**

EXAMINATIONS.

6. **Little Wabash River, Illinois.**
7. **Embarras River, Illinois.**

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UNITED STATES ENGINEER OFFICE,
*Louisville, Ky., July 10, 1893.*

GENERAL: I have the honor to transmit herewith annual reports of operations for the works in my charge for the fiscal year ending June 30, 1893.

Very respectfully, your obedient servant,

G. J. LYDECKER,
*Lieut. Col., Corps of Engineers.*

Brig. Gen. THOMAS L. CASEY,
*Chief of Engineers, U. S. A.*

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## G G 1.

### IMPROVEMENT OF THE FALLS OF THE OHIO RIVER AT LOUISVILLE, KENTUCKY.

The object of the improvement now in progress is to give increased facilities to commerce passing the falls of the Ohio River, via the Louisville and Portland Canal, by enlarging it at its upper entrance, and also at its further end, just above the locks, in such manner as to form suitable basins, or harbors, where boats may lie and tows be properly assembled for passing through the canal and locks without interfering with the movements of other craft.

The enlargement at the entrance to the canal was commenced in 1883 and modified in 1890, as recommended by the Board of Engineers in its report dated January 28, 1890. The general width of the canal before enlargement was 90 feet; by the proposed enlargement this width will become 325 feet at the canal entrance, and from that it will gradually decrease to 210 feet at a point about 2,400 feet west of the entrance; a masonry wall 19 feet high and 2,733 feet long will limit the enlarged canal on its north, and the old north wall will be removed. Eastward of the enlarged canal, at its entrance, a basin about 800 feet wide and 2,200 feet long will be constructed, the limits of the basin being a bear trap structure 800 feet long on the west, and a concrete dam 2,800 feet long on the north. The estimate for the work included the excavation of about 325,670 cubic yards of solid rock and 270,000 cubic yards of earth; the construction of about 5,200 linear feet of new canal wall and masonry dam; and the removal of 6,200 linear feet of old canal wall, crib dikes and timber dam.

The work accomplished up to July 1, 1892, included 177,532.81 cubic yards of earth excavation, 160,882.40 cubic yards of rock excavation, and 10,007.5 cubic yards of masonry built in the new wall.

At the beginning of the past fiscal year the work of building cofferdams, erecting derricks, laying railroad tracks, and other preliminary operations had been commenced for resuming work on the new canal wall (on which nothing had been done since the summer of 1889), and by the middle of July the laying of masonry was started. Preparations for resuming rock excavation at the head of the canal were also commenced early in that month, pumping machinery set up, temporary dams repaired, the mud deposits over the area to be excavated removed, and railway laid, and by the end of the month the actual work of drilling, blasting, and removing rock was well under way; it was continued until the middle of September and then suspended, in order to reserve sufficient funds for continuing work on the canal wall to the close of the season of operations. The stage of water was unusually favorable for the work of excavation, and it was most unfortunate that the amount of money available was so small that full advantage of this condition could not be realized; the work done was less than one-third of that which might easily have been accomplished if the necessary funds had been available. The amount of rock blasted and removed during the short period of work was 13,362.63 cubic yards; for this purpose 4,293 blast holes, aggregating 24,751 feet in length, had been drilled and fired in blasting the solid rock, and 6,959 block holes, aggregating 5,219 feet in length, for breaking the larger masses of blasted rock to size suitable for handling and loading on cars. In these operations 9,469 pounds of forcite and 9 pounds of black powder were used.

In the meantime work on the canal wall was being pushed forward as well as could be expected in the face of several adverse conditions which I could not control; the principal one was the slow rate at which the dimension stone required for the work was delivered by the Salem-Bedford Stone Company, in spite of its engagement early in the season to deliver the entire bill in three months' time, and which it failed to keep in any respect; in that period about one-eighth of the bill was delivered, and up to the end of November, when operations were suspended, but little more than half of the full amount required had been delivered. Because of this failure on the part of the stone company to fulfill its engagements a considerable amount of stone was taken from the old canal wall, cut to shape and dimensions at the site of the work, and used in portions of the new wall below the low-water line. The workings of the act relating to the limitations of the hours of daily service upon public works, approved August 1, 1892, also retarded progress and increased the cost of work, after the middle of August, at which time it was put into effect on the works in my charge.

The work accomplished in connection with the construction of the wall during the season was 22,723 cubic yards of earth excavation, 209.48 cubic yards of rock excavation, and the construction of 3,371.27 cubic yards of masonry. The masonry was placed in three separate sections, one of which was 742 feet long, and each of the others 138 feet long; the latter were built to a height of 14.4 feet, leaving 4.6 feet to complete, and the former to a height of 10.8 feet.

All operations were suspended at the end of November, the plant removed from site of the work and housed so as to be properly protected and preserved until such time as a further appropriation by Congress will permit a resumption of work.

The total work done on the improvements at the head of the canal to June 30, 1893, is as follows: Earth excavation 212,019.31 cubic yards; rock excavation 174,245.03 cubic yards; masonry in new canal wall 13,678.83 cubic yards. The work yet to be done is estimated as follows: Earth excavation 45,481.4 cubic yards; rock excavation 136,205.69 cubic yards; masonry in new canal wall 2,641.73 cubic yards; masonry in dam 10,222.50 cubic yards and bear-trap structures 800 linear feet, and the removal of 6.200 linear feet of old canal wall, crib dikes and timber dam.

On the construction of the enlarged basin above the locks but little work was done during the year, as it had been deemed most advantageous to apply all the money available to pushing the work at the head of the canal. No special force was organized for work at the basin, but the dredges belonging to the canal were employed in removing portions of the old canal wall, when their service was not necessary elsewhere, and the regular force engaged on general work about the locks was used in grading slopes and new roadway as opportunity offered; about 500 cubic yards of the wall was removed by the dredges.

In the progress of this work the following had been accomplished to June 30, 1893:

Earth excavation 141,592 cubic yards; rock excavation 17,744 cubic yards; masonry built in new wall 5,807.38 cubic yards; old wall removed, about 2,544 cubic yards. Besides this a great deal of work had been done in removing shops and other buildings which formerly occupied the site of the enlargement, and their reëstablishment in other localities. To complete the improvement a small portion of the old canal wall remains to be removed, the underlying rock excavated to grade, 50 feet of new canal wall to be built and the earthen slopes about the basin to be properly graded and paved.

The amount expended under appropriations for improving the falls of the Ohio River at Louisville, Ky., to June 30, 1893, was $716,951.17, of which the sum of $98,261.74 was expended during the past fiscal year. The cost of completing the improvments in progress, as originally estimated, will be $550,008.89.

The tabular statement given below shows the extent to which commerce is concerned with these improvements; from this it appears that only 1,286,731 tons of freight passed the falls by river and canal, during the past fiscal year, but the avergc for the six years preceding was 2,536,436 tons annually. The falling off during the last year is undoubtedly owing to the long period during which unusually low water prevailed, and to an entirely exceptional suspension of navigation on account of ice.

In relation to the cost of completing the improvements now in progress, I invite attention to the fact that with small annual appropriations such cost must become far greater than if the appropriations are such as to permit a full season's work after making the very costly preliminary arrangements that must precede each season's operations; cofferdams that are built one year are carried away by the ice and freshets of winter and spring, and have to be rebuilt for the next year's work; long lines of railway have to be built at the beginning of each season and taken up and stored at its close; steam-pumping machinery brought to the work and set up, and boilers and steam piping for the steam drills set up and connected over the site of the work, and many other odd jobs attended to before any season's work can be commenced. Deducting from small appropriations the cost of this kind of work, and we have little left to apply to actual work of excavation and construction; the percentage of expenditure for preliminary works and contingencies becomes in this way inordinately great, the ultimate cost of the improvement very largely increased and the date of its completion indefinitely postponed. With such a favorable season for work as the last one was, it is especially unfortunate to be caught with only a small appropriation available for the work. I would therefore urge the importance of large appropriations for this work in the future, and that the next one be not less than $300,000.

The following is a summary of all appropriations made for the work up to June 30, 1893:

| By the act— | |
|---|---|
| Approved July 5, 1884 | $300,000 |
| Approved August 5, 1886 | 150,000 |
| Approved August 11, 1888 | 150,000 |
| Approved September 19, 1890 | 60,000 |
| Approved July 13, 1892 | 60,000 |
| Total | 720,000 |

I inclose herewith the report of G. W. Shaw, assistant engineer, which describes somewhat more in detail the operations of the year.

*Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $44,963.72 |
| Amount appropriated by act approved July 13, 1892 | 60,000.00 |
| | 104,963.72 |
| June 30, 1893, amount expended during fiscal year | 98,261.74 |
| July 1, 1893, balance unexpended | 6,701.98 |
| July 1, 1893, outstanding liabilities | 1,596.65 |
| July 1, 1893, balance available | 5,105.33 |
| Amount (estimated) required for completion of existing project | 550,008.89 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895 | 300,000.00 |

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1886 and 1887 and of sundry civil act of March 3, 1893.

### REPORT OF MR. G. W. SHAW, ASSISTANT ENGINEER.

LOUISVILLE, KY., *June 30, 1893.*

COLONEL: I have the honor to submit the following report of operations on improving Falls of the Ohio River at Louisville, Ky., enlarging the head of the Louisville and Portland Canal, enlarging basin at head of locks, and new canal wall, for the fiscal year ending June 30, 1893.

*Enlarging head of Louisville and Portland Canal.*—Preparations for work began on July 6, 1892. Tools, machinery, and materials were loaded on barges at the locks and taken to the head of the canal, where boilers, pumps, and engines were unloaded on the guiding dike, set up, and connected. A new crib platform for pump No. 2 was built to replace the one carried away by ice during the winter. Sheds for protection of machinery were erected, and a temporary earth dam was built around the south and east lines of section 3. This dam was afterward extended to a point near the old guard-gate abutment, where the leakage from the canal through part of the guiding dike and through the old wall was discharged into the finished portions of sections 1 and 2. Pumping was commenced with two 12-inch centrifugal pumps on July 23, and the pit was cleared of water on the 26th. The steam drills were started on the 28th and the first blast made on the 31st. Nearly the whole of the area comprising the unfinished portions of sections 2 and 3 was covered with a heavy deposit of sand, gravel, and mud, ranging from 1 to 4 feet deep. The removal of this material, preparatory to drilling, was done principally with carts and wagons, the old quarry beds north of the work being used as a dump. The eastern portion of section 3 was cleared of deposit and projecting points reduced to grade, so that it will not be necessary to pump out this area when work is resumed.

A portion of the cross dam, which was raised 3 feet in 1889 as a protection to the work, was torn away during the winter of 1891-'92 by heavy ice. This was replaced and new braces put in wherever necessary.

In order to more effectually control the leakage through drill holes in the bottom of the pit at the lower end of section 3, pump No. 2 was moved from its original position on the guiding dike to a point nearly opposite Tenth street, on the old canal wall. The rock was excavated and a new crib built for this purpose. A trench for a temporary dam was excavated from the upper end of the new canal wall to a point on the old canal wall near the new pump crib, but the work was suspended before the timber work was begun.

By direction of the officer in charge the work was suspended on September 30. The drilling machinery and tools were transferred to the works on the Indiana Chute, and pumps and other appliances stored at the locks and at the Eighteenth street warehouse. A survey (with cross sections) of the rock ledge above the cross dam was made in September.

It is estimated that the following quantities were excavated and removed from sections 2, 3, and 4 during the season:

| | Cubic yards. |
|---|---|
| Solid rock (in place) | 13,153.15 |
| Earth, mud, etc. (in place) | 11,763.50 |

*New canal wall.*—Tracks for the handling of excavated material and for the transportation of stone along the site of the work were completed early in July, 1892. Excavation on the high bank at the lower end of the wall was loaded into dump cars and carried along the rear of the wall and used as a base for the tracks. The work of the past season comprised the removal of mud and deposit in the two upper openings and similiar work on the extension of the wall west of the railroad bridge, the removal of earth and solid rock for the wing wall connecting the new with the old canal wall, and in filling the above spaces with masonry. The mud having been removed from the upper openings, and a traveler erected for that portion of the work below the railroad bridge, the masonry was begun in August. Stone was laid as fast as it was received until the 1st of December. Both of the upper openings were finished with the exception of the three upper courses, and below the railroad bridge the six lower courses were laid for a distance of 455 feet. The stone was delivered by the Salem-Bedford Stone Company on a switch on the south side of the canal near Sixteenth street. By means of a wire transfer cable the blocks of stone were taken from the cars, carried across the canal and loaded on small flat cars, and delivered along the tracks in the rear of the wall at such points as desired. The last stone was laid in the lower opening December 1, 1892. The traveler was then taken down and the tools and machinery stored at the Fourteenth street yard.

The work of the season is estimated as follows:

| | Cubic yards. |
|---|---|
| Removed earth, mud, etc | 22,723.00 |
| Removed solid rock | 209.48 |
| Masonry laid | 3,371.27 |

*Basin above new locks.*—There remains to be done on this improvement the completion of the short curve joining the new wall to the old one above the pier head of the new locks and the removal of the remainder of the old canal wall and underlying ledge of rock. The dredges and derrick boat, when not employed elsewhere, were engaged in removing parts of the old canal wall during low-water season. The stone from the wall was piled on the south side of the canal opposite the upper end of the basin, and will be used in the construction of roads through the United States property at the locks. It is estimated that the dredges removed about 500 cubic yards of old wall from the basin during the last fiscal year.

The following table shows the amount of work done to June 30, 1893, under the three heads as above:

| | Cubic yards. |
|---|---|
| Enlargement at head of canal: | |
| Earth, loose rock, etc | 189,296.31 |
| Solid rock | 174,035.55 |
| Old wall removed | 500.00 |
| New canal wall: | |
| Earth, mud, etc | 22,723.00 |
| Solid rock | 209.48 |
| New canal wall—Continued. | |
| Masonry laid | 13,678.83 |
| Basin above locks: | |
| Earth, loose rock, etc | 141,593.00 |
| Solid rock | 17,744.69 |
| Masonry laid | 5,807.38 |
| Old wall removed | 2,544.00 |

The amount of work remaining to be done is estimated as follows:

| | Cubic yards. |
|---|---|
| Enlargement at head of canal: | |
| Earth, loose rock, etc | 41,500.00 |
| Solid rock | 131,801.84 |
| New canal wall: | |
| Earth, etc | 3,981.40 |
| New canal wall—Continued. | |
| Solid rock | 4,403.85 |
| Masonry to be laid | 2,641.73 |
| Basin above locks: | |
| Removing old wall | 2,854.87 |
| Masonry to be laid | 275.00 |

In addition to the above there remains to be done in connection with the enlargement at head of canal the following:

| | | |
|---|---|---|
| Removing old canal wall | cubic yards | 7,000.00 |
| Concrete dam | do | 4,822.50 |
| New wall south side of canal | do | 3,100.00 |
| Slope revetment side of canal | do | 2,300.00 |
| Removing part of dam and guiding dike | linear feet | 2,900.00 |
| Bear-trap structure | do | 800.00 |
| Four timber guide piers. | | |

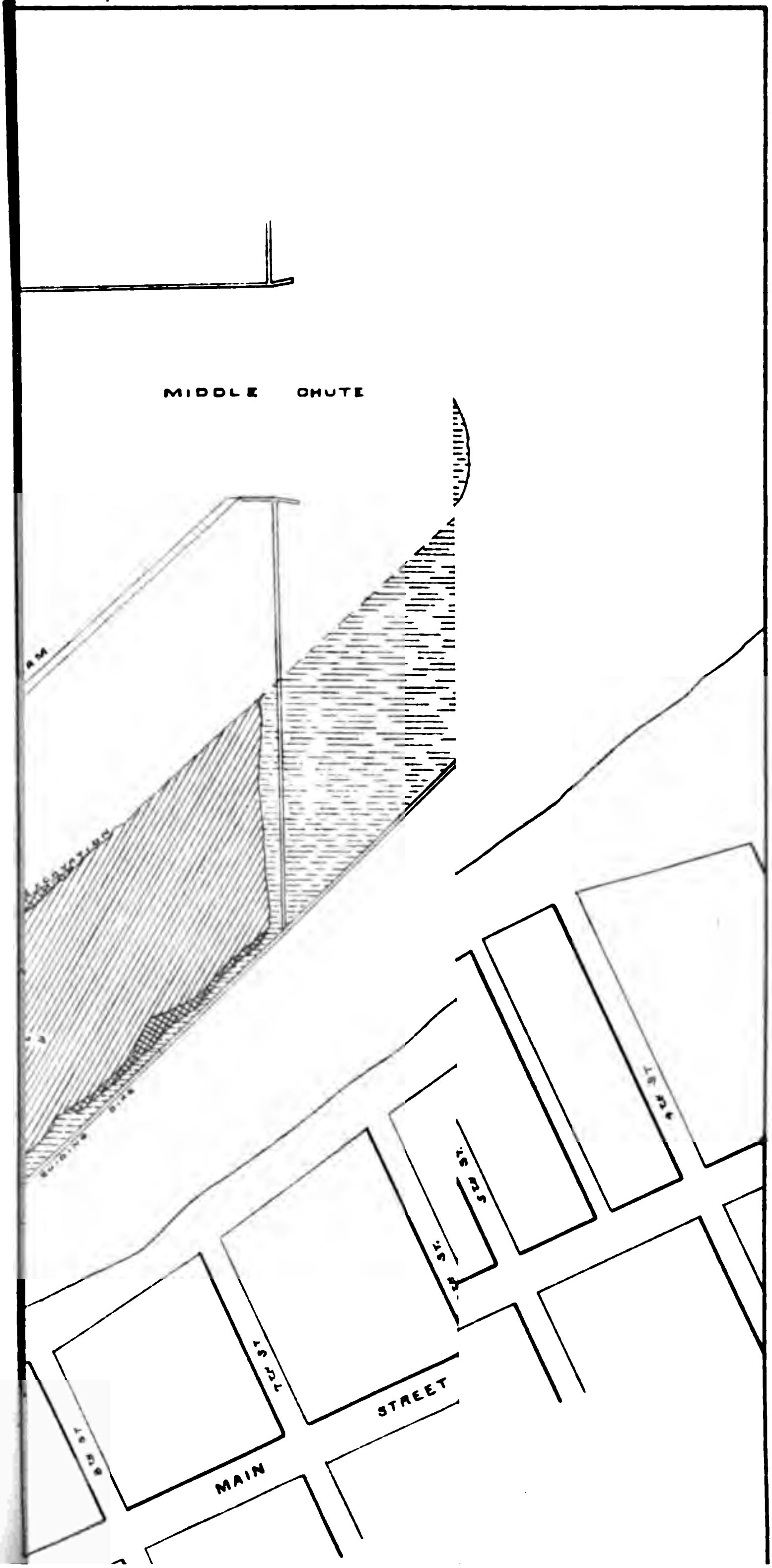
The above estimates do not include the annual deposit of mud, sand, and gravel which must be removed each season before rock excavation can be commenced. The statements above correct some minor errors which have appeared in previous reports.

Herewith is submitted a sketch showing the progress of the work to the end of the present fiscal year.

Very respectfully, your obedient servant,

GRANVILLE W. SHAW,
*Assistant Engineer.*

LIEUT. COL. G. J. LYDECKER,
*Corps of Engineers, U. S. A.*


MIDDLE CHUTE
AM
EXCAVATION
GUIDING DIKE
8th ST
7th ST
MAIN STREET
ST.
5th ST.
4th ST

### COMMERCIAL STATISTICS.

*Statement of commerce passing the Falls of the Ohio River via Louisville and Portland Canal and Indiana Chute, from June 30, 1887, to June 30, 1893.*

| Articles. | From 1887 to 1892. | From 1892 to 1893. | Total for seven years. |
|---|---|---|---|
| | *Tons.* | *Tons.* | *Tons.* |
| Coal | 10,387,851 | 826,876 | 11,214,727 |
| Salt | 71,623 | 8,362 | 79,985 |
| Oil | 47,662 | 2,024 | 49,686 |
| Whisky | 14,803 | 1,630 | 16,433 |
| Tobacco | 60,350 | 4,415 | 64,765 |
| Cotton | 76,261 | 2,874 | 79,135 |
| Lumber | 2,908,562 | 9,872 | 2,918,434 |
| Corn and wheat | 61,363 | 14,866 | 76,229 |
| Iron ore | 270,904 | ............ | 270,904 |
| Iron | 132,005 | ............ | 132,005 |
| Steel rails | 251,080 | 19,992 | 271,072 |
| Produce | 43,148 | 8,709 | 51,857 |
| Hay and straw | 124,832 | 7,971 | 132,803 |
| Flour | 9,652 | 870 | 10,522 |
| Stock | 48,237 | 6,904 | 55,141 |
| Sugar and molasses | 49,394 | 5,943 | 55,337 |
| Staves and shingles | 219,259 | 45,256 | 264,515 |
| Cement | 17,574 | 3,274 | 20,848 |
| Miscellaneous | 424,157 | 113,179 | 537,336 |
| Total | 15,218,717 | 1,083,017 | 16,301,734 |

Annual average during past seven years, 2,328,819.

*Statement of vessels passing Falls of the Ohio River via Louisville and Portland Canal and Indiana Chute, June 30, 1882, to June 30, 1893.*

| Kinds of vessels. | 1882-'92. | | 1893. | | Total for twelve years. | |
|---|---|---|---|---|---|---|
| | *No.* | *Tons.* | *No.* | *Tons.* | *No.* | *Tons.* |
| Passenger boats | 12,105 | 4,932,148 | 801 | 301,749 | 12,906 | 5,233,897 |
| Towboats | 12,953 | 1,708,949 | 1,288 | 160,095 | 14,241 | 1,869,044 |
| Government boats | 1,250 | 89,058 | 298 | 23,939 | 1,548 | 112,997 |
| Coal boats and barges | 48,449 | 16,013,856 | 2,912 | 800,941 | 51,361 | 16,814,797 |
| Small craft | 2,452 | ............ | 199 | 7 | 2,651 | 7 |
| Rafts | 61 | ............ | 2 | ............ | 63 | ............ |
| Total | 77,270 | 22,744,011 | 5,500 | 1,286,731 | 82,770 | 24,030,742 |

Annual average during past twelve years: Boats, 6,898; tons, 2,002,562.

## GG 2.

## IMPROVEMENT OF INDIANA CHUTE, FALLS OF THE OHIO RIVER.

The main channel of the river, by which commerce passes the Falls of the Ohio when the stage of water is such as to permit navigation over them, is known as the Indiana Chute. Originally it was very crooked, with swift currents and whirls, filled with dangerous rocky points projecting from the sides and bottom, and navigable by skilled pilots only when the river was up to or above a stage of about 11 feet on the upper gauge of the Louisville and Portland Canal. By blasting and removing these projections the channel has been materially improved and straightened, and is now easily available for descending navigation when the river reaches 10 feet on the gauge, but is little used for ascending navigation until the river becomes a foot higher because of the strong current. When the stage of 12.7 feet on the gauge is reached the locks of the canal can no longer be used, and all commerce readily passes over the falls by river, the other river channels, known as the Middle Chute, and Varble Chute, being used as well as the Indiana Chute at the higher stages of water. At extreme high water some of the larger classes of steamers can not use the Indiana or Middle chutes because of the fixed spans in the bridge over them. In this case the line of navigation is via the upper portion of the canal, through the draw span of the bridge, and thence into the river via the Varble Chute, as the passage provided for such traffic over the river wall of the canal is popularly called. A dam extends across the river at the head of the falls, from the guiding dike at the entrance to the canal on the Kentucky side to the Indiana shore; openings 500 feet long and 600 feet long are provided where the dam crosses the Middle and Indiana chutes respectively, all of the first-named opening, and 160 feet of the last being arranged with movable dams, which may be set up during periods of low water.

Returning now to the Indiana Chute, the project for its radical improvement now in progress is that recommended by the Board of Engineers, constituted by S. O. No. 68, dated Headquarters Corps of Engineers, U. S. Army, November 27, 1888, in its report dated January 28, 1890. The object is to make the channel safely navigable for descending commerce, when the river is not below a stage of 8 feet on the canal gauge, *i. e.*, at a stage 2 feet below that at which tows or large boats can safely pass at present, except by the slow route through the canal and locks; it is expected to accomplish this by the construction of dikes on the sides of the channel and by a modification of the cross dam at the head of the falls, in such manner as to regulate the flow of water when the river is at the designated stage, so as to establish a more uniform slope of its surface, and by the excavation of rock to secure a channel depth of not less than 8 feet below the plane of the new water surface. The principal items of work involved in the realization of this project are the excavation of about 60,000 cubic yards of solid rock, the construction of 3,700 linear feet of stone dikes and a concrete wall 850 feet long. The exact final extent and location of the dikes and dams will be determined on further study of results produced during the progress of the work. The location of the work is such that it can be carried on with due regard to economy at periods of very low water only, and up to the end of June, 1892, operations had been limited to the removal of a comparatively small amount of rock from scattering points and reefs in the upper part of the chute, from the cross dam down to the Ohio River Bridge, a distance of 2,800 feet; and to repairing and raising the old crib dike on the north side of the chute, extending 575 feet downstream from the cross dam.

Operations during the past year included a continuation of the removal of rock from the section above the bridge, and also a commencement of the principal work of rock excavation at Willow Point and Wave Rock in the section below the bridge, together with a beginning of the terminal dikes projected for that section.

It was not until the 24th of August that the river conditions were such as to justify anything being done, but on that date operations were inaugurated by transporting to the site of the work the machinery and material required for its vigorous prosecution; boilers for operating the steam drills were set up, temporary breakwaters, deflecting dams, blacksmith shop, and tool sheds erected, and by the 1st of September everything was in readiness for commencing the actual work of rock excavation at the several points, viz: on the north reef in the upper section, and on Wave Rock and Willow Point in the lower. At the first-named point the work being in the nature of trimming—and scattered—was done by hand drilling; but in the lower section, where deep cutting and continuous excavation were required it was pushed forward by steam drills, fourteen of which were in use. The season proved to be an exceptionally favorable one, and operations were continued without interruption until the 18th of November, when the river rose to such a point as to put a stop to the further removal of rock, though steam drilling on the more elevated portions of Wave Rock and Willow Point was not stopped until the 29th, when it became necessary to suspend all operations and remove all machinery from the site of the work. The total amount of rock excavated and removed during the season was 27,586.62 cubic yards; in doing this 4,629 blast holes, aggregating 6,006 feet in length were drilled by hand, and 9,156 holes, aggregating 32,023 linear feet by steam drills; the work of blasting was done with 11,644 pounds forcite.

The rock taken from Willow Point and Wave Rock was deposited in the dikes which will define the improved channel below these points, and sufficed to build 1,234 linear feet of the Willow Point dike to an average height of 9 feet, with a top width of 40 feet, and 400 feet of the Wave Rock dike to a mean height of 10 feet and top width of 40 feet.

To complete the work contemplated by the present project requires the excavation of some 21,212 cubic yards of rock at Willow Point and Wave Rock, the building of 35,050 cubic yards of stone dikes, 850 feet of concrete wall, 2,500 cubic yards rock excavation at right and left hand reef. The importance of the work has been fully set forth in previous reports, and may be summarized in the statement that when the improvement is completed a large part of the commerce passing this point will be saved the delays incident to going through the canal and locks. Especially important would this be to the coal traffic, which amounts to over one and one-half million tons annually, nearly all of which would then pass the Falls by the Indiana Chute. The condition to which the work is now advanced is such that if the necessary money be made available one season of ordinary low water will suffice for its completion, and the appropriation of $60,000, the amount required for that purpose, is earnestly recommended.

The report of G. W. Shaw, assistant engineer, in immediate charge of the work, is transmitted herewith.

The following is a summary of all appropriations made for the work up to June 30, 1893:

| | |
|---|---|
| By the act— | |
| Approved July 5, 1884 | $10,000 |
| Approved August 5, 1886 | 20,000 |
| Of August 11, 1888 | 15,000 |
| Approved September 19, 1890 | 25,000 |
| Approved July 13, 1892 | 35,000 |
| Total | 105,000 |

In addition allotments from the general appropriations for improving the Ohio River, aggregating $95,000, were made for improving this chute before it became the subject of specific appropriations.

### *Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $27,523.7 |
| Amount appropriated by act approved July 13, 1892 | 35,000.0 |
| | 62,523.7 |
| June 30, 1893, amount expended during fiscal year | 50,378.0 |
| July 1, 1893, balance unexpended | 12,145.6 |
| July 1, 1893, outstanding liabilities | 180.3 |
| July 1, 1893, balance available | 11,965.1 |
| Amount (estimated) required for completion of existing project | 60,000.0 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895 | 60,000.0 |
| Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893. | |

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REPORT OF MR. G. W. SHAW, ASSISTANT ENGINEER.

LOUISVILLE, KY., *June 30, 1893.*

COLONEL: I have the honor to submit the following report of operations on improving Falls of the Ohio River, Indiana Chute, for the fiscal year ending June 30, 1893:

The work of the season of 1892 was directed to the removal of Right Hand Reef, the partial removal of Willow Point and Wave Rock, and the building of stone dikes below both the latter points.

Preparations were begun on August 24, 1892, by loading barges at the locks and at the head of the canal with tools, machinery, and such appliances as could then be spared from the enlargement at the head of the canal. On the 27th the movable dam in the middle chute was raised, loaded barges were transferred to the head of the chute on the 28th, and work on a breakwater at Right Hand Reef was begun on the 29th. On the same date a small force commenced removing the loose ledges on Wave Rock. By the 31st two barges for the transfer of employés, teams, and supplies were taken to Wave Rock and a temporary blacksmith shed erected at Willow Point.

By September 6 the breakwater at Right Hand Reef was completed and excavation under way. Excavated material was wheeled north of the line of improvement and deposited in piles to be utilized in a stone guide wall. On the 7th two steam drills were started at Wave Rock, and on the 19th two more were added. Lines of dikes were located and the excavated material placed in same by means of carts. At Willow Point drilling was begun September 9 and blasting on the 19th. On this work excavated material was handled by carts until October 17, when track and cars from the work at the head of the canal were brought over and utilized in building the dike. Excavation at Willow Point and Wave Rock was continued until November 18, on which date all work except drilling was suspended on account of cold weather. Drilling was suspended November 29 in anticipation of high water, and the tools and machinery were placed on barges, taken to the canal, and stored for the winter.

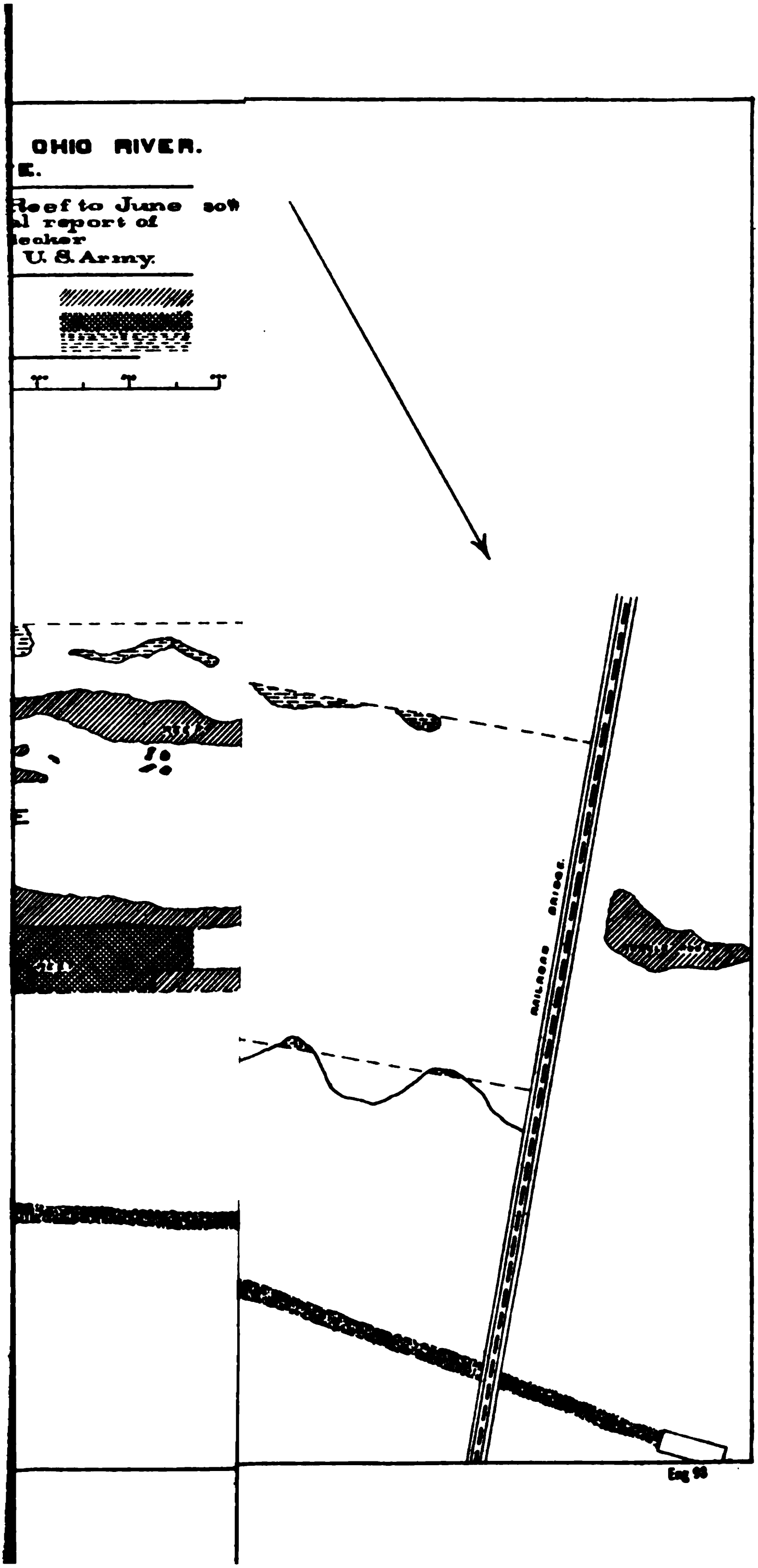
At Right Hand Reef work was continued until November 6, when the weather became too severe for men to go in the water. The breakwater was removed, appliances loaded on barges and stored at the Eighteenth street yard.

The movable dam, Indiana Chute, was raised September 14, and after some slight repairs lowered again. The movable dam, Middle Chute, was lowered November 16, the wickets for both structures stored in the wicket boat, and the latter sent to the locks for winter quarters.

Buoys made of timber and about 16 feet long were anchored to the unfinished ends of the dikes below Willow Point and Wave Rock. A similar buoy was placed on the upper end of the raised portion of the guiding dike at the head of the chute. At the lower end of Goose Island a dump was started with a view to intersecting the dike opposite that point, so that the work next season may be carried on from both ends of the dike below Wave Rock.

The following is an estimate of the work done during the last fiscal year. The quantities are measured loose:

| | Cubic yards. |
|---|---|
| Rock excavation, Right Hand Reef | 3,722.67 |
| Rock excavation, Wave Rock | 12,064.00 |
| Rock excavation, Willow Point | 11,800.00 |
| Total | 27,586.67 |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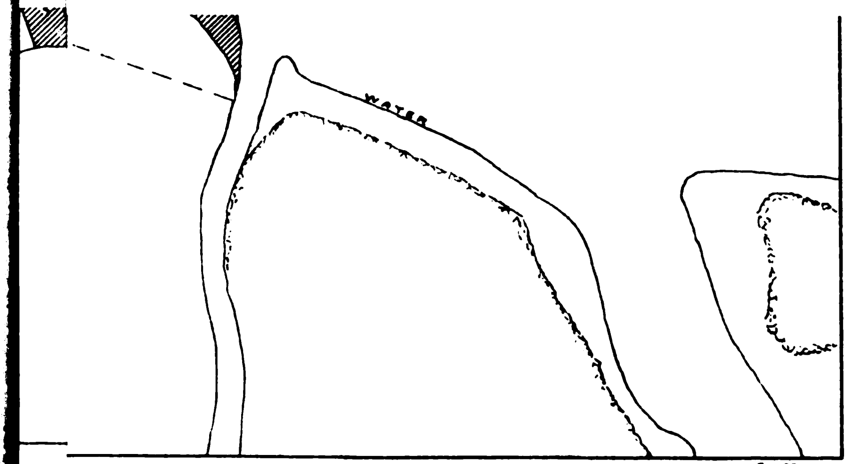

Eng 93

In the above work there were drilled by steam 9,156 holes, aggregating 32,023 feet, and by hand 4,629 holes, aggregating 6,006 feet. There were 11,644 pounds of dynamite used in blasting.

The dike at Wave Rock was finished to Ref. 20, 400 feet long and 40 feet wide at the top. That portion at the lower end of Goose Island was built to Ref. 21, 230 feet long and the same width at top. Willow Point Dike was finished to Ref. 22, 50 feet wide and 1,234 feet long, this being the length as originally designed. During the winter of 1892–'93 the river was frozen over for several weeks, and a number of heavy gorges formed above Louisville. The accumulation of ice in front of the city and against the cross dam resulted in the tearing away of all the raised portion of the cross dam except about 50 feet next to the guiding dike on the Kentucky side. Two gaps, ranging from 50 to 75 feet wide, were also made in the cross dam south of the Middle Chute. The guiding dike north of the canal lost about 250 feet of its upper end. The exact amount of damage done to these structures can not be determined until the river falls to a 5-foot stage.

There remains to be done in connection with the Indiana Chute the repairs of the cross dam and dike and the following:

| | Cubic yards. |
|---|---|
| Excavation, Right Hand Reef | 500 |
| Excavation, Willow Point, in place | 11, 242 |
| Excavation, Wave Rock, in place | 9, 470 |
| Excavation, Left Hand Reef | 2, 000 |
| Dike at Wave Rock | 27, 550 |
| Dike at Willow Point | 7, 500 |
| Guide wall above bridge | 7, 450 |

Very respectfully, your obedient servant,

GRANVILLE W. SHAW,
*Assistant Engineer.*

Lieut. Col. G. J. LYDECKER,
*Corps of Engineers, U. S. A.*

## COMMERCIAL STATISTICS.

*Statement of vessels passing Falls of the Ohio River, via Indiana Chute, for fiscal year ending June 30, 1893.*

| Kind of vessel. | No. | Tonnage. |
|---|---|---|
| Passenger boats | 228 | 111, 870 |
| Towboats | 502 | 78, 058 |
| Square barges | 966 | 316, 372 |
| Model barges | 20 | 5, 064 |
| Total | 1, 716 | 511, 364 |

Days navigable: Ascending, 63; descending, 164.

*Statement of commerce passing Falls of the Ohio River, via Indiana Chute, for fiscal year ending June 30, 1893.*

| Articles. | Tons. | Articles. | Tons. |
|---|---|---|---|
| Coal | 482, 464 | Iron | ........ |
| Salt | 1, 359 | Miscellaneous | 32, 662 |
| Oil | 574 | Produce | 245 |
| Whisky | 428 | Flour | 120 |
| Tobacco | 1, 056 | Sugar and molasses | 2, 639 |
| Cotton | 1, 018 | Hay and straw | 2, 039 |
| Lumber | 2, 098 | Live stock | 1, 399 |
| Corn | 793 | Staves and shingles | 5, 098 |
| Wheat | 472 | Cement | 2, 437 |
| Iron ore | ........ | | |
| Steel rails | 8, 652 | Total | 545, 553 |

Number of passengers, 4,313.

## G G 3.

## OPERATING AND CARE OF LOUISVILLE AND PORTLAND CANAL, KENTUCKY.

Operations connected with the canal during the past year were conducted in the usual manner until the spring of 1893, when some changes were made whereby the control of affairs has been simplified, and the cost of superintendence reduced. Before that time the management and care of the canal was supervised by two independent executive officers, acting under the United States engineer in charge of the river and harbor district in which the canal is located. Matters relating to traffic through the canal and locks were in charge of a master lock manager, who had under his orders a regular force consisting of 1 deputy lock-manager, 1 lock-master, 1 assistant lock-master, 4 engineers, 4 firemen, 4 lock hands, 1 bridge-tender, and 1 night watchman. All matters connected with the care of the canal and locks, their repairs, and everything pertaining to their serviceable condition, were in charge of an assistant engineer who directed the operations of such force, as might be required from time to time for the work in hand, which force would quite frequently include members of the regular canal force, whose official head was the master lock-manager. This condition of affairs brought about conflicts such as are usual in like cases, embarrassing alike to operations on the canal and to the superior officer charged with the general control of affairs. The conditions became all the more serious when the United States engineer was deprived of all voice in the selection of these agents charged with the immediate control of operations for which he is held to a rigid financial and professional responsibility. In view of these facts a report was submitted in March, 1893, recommending certain changes which were afterward carried into effect. The resignation of the assistant engineer was accepted to take effect March 18; the services of the master lock-manager discontinued March 31, and on April 7 their duties were consolidated, and Lieut. H. M. Chittenden, Corps of Engineers, U. S. Army, placed in immediate charge of all matters relating thereto. A much more satisfactory organization has been thereby secured and the cost of superintendence materially reduced.

The canal was open to navigation on two hundred and ninety-four days and closed seventy-one days; high water was the cause of closing on thirty-six days, ice on twenty-nine days, and the remainder because of occasional repairs to locks and for putting new middle gates in place. The total number of lockages during the year was 1,826, the number of craft passing the locks being 3,784, having a total tonnage of 775,367, and carrying 537,464 tons of freight.

The principal operations during the year, besides those relating to traffic through the canal, are briefly summarized as follows:

### DREDGING.

The two dredges, with towboat and four mud scows, were at work throughout the year, except when laid up for repairs or interrupted by high water and ice; the extreme low water which prevailed during the fall of 1892 likewise interfered with these operations. The amount dredged from the canal was 67,050 cubic yards, besides which 720 cubic yards of rock was removed by the dredges from the old canal wall in enlarging the canal basin above the locks; a considerable part of the stone so removed was taken to the head of the canal and used in the foundation courses of the new wall at that place.

### NEW MIDDLE GATES.

The pair of new middle gates which have been completed during the preceding year were erected in place without mishap, though the time occupied was considerably longer than was anticipated, the locks being closed to navigation from November 20 to 26 for that purpose; no material interference with traffic resulted, as the old locks were utilized for the passage of such small-sized boats as were in commission on the river at that time, all the larger ones having been laid off because of a long low-water season.

### TRIMMING CANAL WALL.

The long season of low water was very favorable for this work, so that the rock projections and irregularities of the canal wall, and underlying rock in place, were all removed on the south side; boats can now pass through the canal without risk of such damage as these projections formerly offered during low-water periods. At the same time, considerable rock was excavated from the channel below the locks, but the great bulk of the work required for excavating this channel to grade remains to be done.

### NEW MACHINE SHOP.

The new buildings for machine shop, boiler and engine house—designed to replace the old frame structures that were destroyed by fire during the winter of 1892—were completed in August, boiler and engine set up and put in operation. The new buildings are substantial structures of stone masonry, with iron roofs and concrete floors. The aim has been to make them as nearly fireproof as possible. The other frame buildings, which escaped destruction during the fire only because there was no wind at the time, should be rebuilt in masonry as opportunity offers; these are the blacksmith shop, carpenter shop, and store house.

### EXTENDING CITY WATER SUPPLY TO LOCKS.

A satisfactory arrangement for introducing the city water supply to the locks and adjoining grounds was concluded with the Louisville Water Company in April, and since that time the company has extended its main to the Government grounds, and placed a water meter in position. From this point the supply will be carried through the grounds by a 6-inch main crossing the canal above the locks, and passing near the principal buildings on the lock grounds; a 4-inch branch main will take the supply to the office building, residence, and stables; six fire hydrants will be placed on the line of those mains, and the necessary connections made for serving the water to the several buildings. The pipe for mains has been purchased and delivered, comprising 40,750 pounds 6-inch cast-iron pipe, 13,493 pounds 4-inch cast-iron pipe, and 4,587 pounds special castings. It will be laid during the summer.

### MISCELLANEOUS REPAIRS, ETC.

Considerable repairs were made to the two dredges, towboat and, mud scows, two of the latter being entirely rebuilt. The drawbridges over the new and old locks, and that over the canal at Eighteenth street, were the subject of numerous repairs to maintain them in working order. The principal work was on the latter, which was supplied with new maneuvering pinion and with new rack on turntable, new bearings and rollers at abutments, and a new flooring. This bridge carries a heavy traffic, and should be replaced by a new one during the coming year. The lower chord is fractured in two places, a number of tie-rods are considerably worn, and in other respects its condition is very unsatisfactory. The office building and residence at the locks have had some repairs, the principal feature of which was replacing rotten wood work of porches. Several hundred feet of old rotten fencing have been removed and replaced.

## PROPOSED WORK FOR YEAR ENDING JUNE 30, 1894.

In addition to the regular work required for the proper care and operation of the canal, it is proposed to build new guard gates for the old locks, to revet the earthen slopes adjoining the new basin above the locks up to the ordinary high-water line, to excavate to grade the rock in the channel below the locks, to build a hydraulic dredge, to repair slopes and revetment at new locks, to renew pavement at locks, and to replace the three bridges over the canal. Most of the work involved in this project was included in the allotment made for the past year; the work now proposed, in addition thereto, is as follows: New bridge at Eighteenth street, at an estimated cost of $12,000; removing pavement at new locks, 2,705 square yards, $5,500; replacing slope revetment at new locks, $3,500. The condition of the present bridge at Eighteenth street is now such that it can no longer be trusted to stand the heavy traffic over it; I reported it as unsafe in 1891, but it has been kept in service since then with careful watching and by numerous repairs, but, as before stated in this report, its lower chord is now fractured in two places, and a number of the tie-rods are worn to the extreme limits of safety. It is of the same type as the bridge at the new locks (though longer) which was to have been replaced during the past year, but no satisfactory bids were received for so doing, and it is believed that the two can be rebuilt together to the best advantage and at considerably less cost than if built separately, and these two old bridges will supply all the material required for the smaller and less-important structure for replacing the old wooden drawbridge over the old locks; last year's allotment for new bridges at new and old locks is, accordingly changed for the coming year to "New bridges at Egihteenth street, new locks, and old locks," and the amount increased from $16,000 to $28,000. The cement pavement at the new locks, extending from the face of the lock walls to the foot of slope revetment, was laid many years ago, and is now all broken up and disintegrated; it can not be patched up, but must be relaid throughout.

The slopes adjoining the locks are revetted in stone to the height of ordinary high water, and this revetment has become undermined to such extent that each recurring high water tears out a patch of varying extent; by the high water and ice of last winter about 300 feet were carried away, so that its reconstruction should no longer be delayed; the estimate of $3,500 for renewing slope revetment at locks is submitted for the purpose. The estimates for regular force, extra labor, general repairs, etc., and contingencies for the ensuing year are reduced by $4,500 as compared with last year's allotment.

The estimate for operating and care of the canal for the year ending June 30, 1894, on the basis above indicated, is as follows:

| | |
|---|---|
| Regular force | $33,500.00 |
| Extra labor | 6,000.00 |
| General repairs | 6,000.00 |
| Miscellaneous, fuel, oil, etc | 7,000.00 |
| New guard gates, old locks | 6,000.00 |
| New bridges, Eighteenth street, new locks and old locks | 28,000.00 |
| Hydraulic dredge | 20,000.00 |
| Slope revetment above new locks | 4,000.00 |
| Rock excavation, channel below locks | 14,000.00 |
| Extending city water supply to locks | 2,000.00 |
| New pavement at locks | 5,500.00 |
| Renewing slope revetment at locks | 3,500.00 |
| Contingencies | 6,000.00 |
| Total | 141,500.00 |
| The unexpended balance of last year's allotment, excluding liabilities outstanding June 30, 1893, is | 64,341.32 |
| Additional allotment for year ending June 30, 1894 | 77,158.68 |

The following statements of expenditures on the canal and of commerce and traffic for the year ending June 30, 1893, are submitted:

*Financial statement for operating and care of the Louisville and Portland Canal for the fiscal year ending June 30, 1893.*

| | |
|---|---|
| Receipts: | |
| Dockage | $1,040.61 |
| Rent of land | 285.00 |
| Total | 1,325.61 |
| Expenditures: | |
| Office and general administration | 4,695.84 |
| Canal and locks | 43,034.71 |
| Dredging | 16,722.51 |
| Total | 64,453.06 |
| New bridges at new and old locks | 128.20 |
| Completing repairs to old mud scows | 2,287.37 |
| Trimming canal wall and rock below | 2,480.11 |
| Aggregate | 69,348.74 |

*Statement of expenditures for operating and care of Louisville and Portland Canal for the year ending June 30, 1893.*

| | |
|---|---|
| Office and general administration: | |
| Salaries | $3,078.67 |
| Supplies | 177.30 |
| Miscellaneous | 1,439.87 |
| Total | 4,695.84 |
| Canal and locks: | |
| Labor | 22,125.44 |
| Supplies | 5,529.52 |
| Repairs and extra labor | 15,379.75 |
| Total | 43,034.71 |

| | |
|---|---|
| **Dredging:** | |
| Labor | $11,041 |
| Supplies | 2,056 |
| Repairs and extra labor | 3,624 |
| Total | 16,722 |
| Grand total | 64,453 |
| New bridges at new and old locks | 128 |
| Completing repairs to old mud scows | 2,287 |
| Trimming canal wall and rock below | 2,480 |
| Aggregate | 69,348 |

*Abstract of proposals for furnishing coal received in response to the advertisement dated May 2, 1893, and opened June 30, 1893, by Lieut. Col. G. J. Lydecker, Corps of Engineers.*

| Kind of coal. | Quantity (more or less). | Bid of Austin H. Dugan |
|---|---|---|
| Best Pittsburg coal........bushels.. | 10,800 | [illegible] |
| Second pool Pittsburg coal........do.... | 1,000 | [illegible] |
| Ohio River or Kanawha coal........do.... | 35,500 | [illegible] |
| Anthracite egg coal........tons.. | 10 | [illegible] |
| Anthracite nut coal........do.... | 10 | [illegible] |
| Total | .......... | 4,6[illegible] |

*Abstract of proposals for constructing and erecting a new drawbridge at the locks of the Louisville and Portland Canal and for removing the present bridge, received in response to the advertisement dated May 22, 1893, and opened June 21, 1893, by Lieut. Col. G. J. Lydecker, Corps of Engineers.*

| No. | Name of bidder. | Price. | To be completed— |
|---|---|---|---|
| 1 | Groton Bridge and Manufacturing Co | $12,600 | No date given |
| 2 | The King Bridge Co | 12,550 | Nov. 1, [illegible] |
| 3 | The Iron Substructure Co | 13,500 | Dec. 31, [illegible] |
| 4 | Pennsylvania Bridge Co | 11,987 | Dec. 1, [illegible] |
| 5 | Wisconsin Bridge and Iron Co | *13,200 | Sept. 22, [illegible] |
| 6 | Shiffler Bridge Co | 13,900 | Dec. 1, [illegible] |
| 7 | Louisville Bridge and Iron Co | 13,431 | Nov. 1, [illegible] |
| 8 | J. G. Wagner Milwaukee Bridge and Iron Works | 14,885 | Oct. 1, [illegible] |

* Or $12,649 if steel joists are used.

All proposals recommended for rejection; prices deemed excessive.

COMMERCIAL STATISTICS.

*Statement of vessels passed through the Louisville and Portland Canal during the fiscal year ending June 30, 1893.*

| Vessels. | Number. | Capacity |
|---|---|---|
| | | Tons. |
| Passenger boats | 573 | [illegible] |
| Towboats | 786 | [illegible] |
| Government boats | 298 | [illegible] |
| Coal boats and barges | 1,926 | [illegible] |
| Small craft | 199 | |
| Rafts | 2 | .......... |
| Total | 3,784 | [illegible] |

Lockages, 1,826.

*Statement of commerce passed through the Louisville and Portland Canal during the fiscal year ending June 30, 1893.*

| Articles. | Tons. | Articles. | Tons. |
|---|---|---|---|
| Coal | 344,412 | Steel rails | 11,340 |
| Salt | 7,003 | Iron manufactured | .......... |
| Oil | 1,450 | Produce | 8,464 |
| Whisky | 1,202 | Flour | 750 |
| Tobacco | 3,359 | Sugar and molasses | 3,304 |
| Cotton | 1,856 | Hay and straw | 5,932 |
| Lumber | 7,774 | Live stock | 5,505 |
| Corn | 7,462 | Cement | 837 |
| Wheat | 6,139 | Staves and shingles | 40,158 |
| Miscellaneous | 80,517 | | |
| Iron ore | .......... | | 537,464 |

Total tons, 537,464. Number of passengers, 16,801.

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## G G 4.

### IMPROVEMENT OF WABASH RIVER, INDIANA AND ILLINOIS.

The object sought by the project for improving this stream is a reliable channel with a depth of not less then 3 feet at low water from Terre Haute, Ind., to its mouth, about 250 miles below. Its improvement by the General Government was not undertaken until 1872, but before that time the Wabash Navigation Company, acting under authority conferred by the legislatures of Indiana and Illinois in 1846 and 1847, had constructed a lock and dam for passing the Grand Rapids near Mount Carmel, Ill., at a cost of about $70,000. At the time the Government succeeded to the rights of the navigation company this lock and dam was reported as altogether unserviceable, and as having become in fact, a greater obstruction to navigation than the original rapids. The project of improvement thereupon adopted was that submitted by Maj. G. Weitzel, Corps of Engineers, U. S. Army, in his report dated January 4, 1872, which is published on pages 472–475 of the Report of the Chief of Engineers for 1872. This report states that in the distance of 175 miles from its mouth there are twelve points that require special improvement, and that "the whole river needs a general improvement by means of light-draft dredges and snag boats," and the estimated cost of the proposed work was summarized as follows:

| | |
|---|---|
| 1. Little Chain | $62,925.86 |
| 2. Grand Chain | 28,546.70 |
| 3. Warwick Ripple | 2,592.00 |
| 4. Tow heads below New Harmony | 2,222.25 |
| 5. New Harmony Cut-off | 14,526.62 |
| 7. White River Shoals | 3,901.03 |
| 8. Grand Rapids | 135,000.00 |
| 9. Little Rock | 500.00 |
| 10. Nine Mile Ripple | 2,775.00 |
| 11. Horseshoe Bend | 4,629.12 |
| 12. Swan Island | 5,787.02 |
| Dredging and snagging | 14,400.00 |
| | 284,247.84 |
| Add 10 per cent for superintendence and contingencies | 28,424.78 |
| Total | 312,672.62 |

The foregoing estimate was based on a hasty survey, and subsequent surveys showed that a complete improvement of the river would require much additional work. It also contemplated the completion of the work indicated in two working seasons, and to begin with an appropriation of $175,000. The first appropriation was made by the act approved June 10, 1872, which required that the work should be commenced at its mouth, and the work thereupon commenced has been continued under subsequent appropriations. All work done prior to 1881 was between the mouth of the river up to Grayville, Ill., and by far the greater portion of it was confined to a length of about 40 miles, extending from Grand Chain to about 7 miles above Grayville. The results accomplished are summarized in the report of the officer in charge for 1891 in the statement that originally "this entire distance could scarcely be passed with a skiff at extreme low water, while at present all the usual river boats can readily and regularly make trips at all stages of the river."

The principal points which were the subject of special improvements by excavating channels through reefs and the construction of dikes and dams to close cuts-off, secondary channels, etc., were at or near Little Chain, Grand Chain, Warwick Ripple, New Harmony, Coffee Island, Grayville, Winklers Bar, and McIntyres Bar. In addition to this special work, general snagging and dredging operations were carried on as required for keeping the river open to navigation.

The total expenditure to June 30, 1881, was $331,049.71, all of which was for work done below Mt. Carmel, Ill. The act of March 3, 1881, required that one-half of the $50,000 therein appropriated should be applied to improvements above Vincennes, Ind., and since that time separate appropriations have been made for improvements above and below that place. The character of work done continued to be the same as that above indicated until 1884, when the act approved July 5, 1884, appropriated $30,000 for "improving Wabash River by lock and dam at Grand Rapids." This money was applied to a contract for furnishing a small portion of the stone required for the lock, and under subsequent appropriations the lock and masonry abutments of the dam have been completed in a most substantial manner, as described in Annual Reports from 1886 to 1892. During the same period considerable work was done at Grayville and New Harmony, and in removing snags from other parts of the river.

The operations on the two sections of the river during the fiscal year ending June 30, 1893, were as described below:

### IMPROVEMENTS BELOW VINCENNES.

It had been intended to commence the work of constructing the dam at Grand Rapids, but it was not found practicable to obtain the large amount of timber and stone required for the work in time to carry the construction far enough to secure it against damage by the floods and ice of winter and spring. It was, therefore, determined to quarry the necessary stone during the low water season, when the work could be done to the best advantage, and boat it to the site of the dam when the river reached a suitable stage, and also to make a contract for the delivery of about 1,000,000 feet of oak timber required for the cribwork, so that it might be got out during the winter and delivered during spring following, and by these means to have all the necessary material on hand for the work of construction during the next low-water season, the only time at which such work is practicable. Accordingly, after careful examination, a suitable stone quarry was selected about 10 miles above the site of the proposed dam, and arrangements made with its owner for taking all the stone we required on payment to him of 5 cents per cubic yard for the stone taken. Operations were commenced in the latter part of October, 1892, and continued until early in March, 1893, but with considerable interruptions during January and February on account of the severity of the weather; the stone taken out was piled on a temporary crib wharf, built for the purpose at a convenient point near the quarry, and transported from there to the site of the dam after the river reached a favorable boating stage, about the middle of March. The amount of stone quarried and piled was 9,095 cubic yards, of which 5,420 cubic yards had been boated to the site of the dam and placed in convenient position for filling the crib structure as fast as it is built. The cost of the stone so delivered, including the price paid to the owner of the quarry, has been about $1.57 per cubic yard.

Advertisements inviting proposals for furnishing timber were published November 21, 1892, and contract entered into with the lowest bidder, H. C. Jones, of Madison, Ind., for the entire bill of 1,004,353 feet B. M. for $22,407.84. Up to June 30, 1893, he had delivered 113,402 feet B. M. This delivery is far below the amount called for by his contract, the winter and spring having been very unfavorable for the work; but the contractor has three mills in operation at this writing, and the indications are that he will be able to complete his contract without causing any material delay to the progress of the work of construction, which is about to be commenced. Before this could be done it was necessary to clear out a large amount of mud and débris overlying the foundation bed of the dam; 7,050 cubic yards of such deposit has been removed by dredging, and there remains about a thousand yards that will have to be removed by work of hand.

The only other work that was done on this portion of the river was the reconstruction of the snag boat *Osseo*, which was in progress at the beginning of the year, and completed early in October; she was not put in commission, however, because the stage of water was too low to permit work to be done to advantage, and besides it was deemed more important to reserve all the money available for work on the new dam. The navigable condition of this section of the river has not changed materially since my last annual report, and is by no means satisfactory, notwithstanding the large amount of work done on it in years past. The channels heretofore made have become badly obstructed, dikes and dams have been destroyed, new shoals have formed from the material supplied by caving banks, and for these reasons a large amount of work is required to restore the river to the condition it was in when general work was in a great measure suspended seven years ago, in order not to interfere with the earliest possible completion of the lock and dam at Grand Rapids.

The balance now available will hardly suffice to complete the dam, and when this is done an expenditure of about $10,000 will be required to build the necessary wing walls for covering the approaches to the lock from above and below. An expenditure of $50,000 on the hundred miles of river below is the least that will afford any considerable relief from its present obstructed condition. The officer in charge of this work in 1886 submitted an estimate of $160,600 (in addition to the $150,000 required for the lock and dam at Grand Rapids) as necessary for work on this section of the river. The temporary and scattered character of work done since then does not permit a reduction of this estimate below $150,000 at the present time.

The inclosed report of O. L. Petitdidier includes some additional details in relation to operations during the year, and supplies statements relating to commerce. These show only a small traffic by four steamboats carrying a total of 49,783 tons of freight valued at $275,460. This is a falling off of 11,102 tons and a reduction in value of $536,987.50 as compared with the year before. It is stated that the condition of affairs is the result of poor crops in the country tributary to the river, but it is more likely to have arisen from the obstructed condition of the river, combined with the facilities for shipping products of the Wabash Valley by rail.

The following is a summary of all appropriations made for the work up to June 30, 1893.

| By the act— | |
|---|---|
| Approved June 10, 1872 | $50,000 |
| Approved March 3, 1873 | 50,000 |
| Approved June 23, 1874 | 25,000 |
| Approved March 3, 1875 | 40,000 |
| Approved August 14, 1876 | 70,000 |
| Approved June 18, 1878 | 50,000 |
| Approved March 3, 1879 | 20,000 |
| Approved June 14, 1880 | 25,000 |
| Approved March 3, 1881 | 25,000 |
| Approved August 2, 1882 | $40,000 |
| Approved July 5, 1884 | 30,000 |
| Approved August 5, 1886 | 60,000 |
| Of August 11, 1888 | 60,000 |
| Approved Sept. 19, 1890 | 60,000 |
| Approved July 13, 1892 | 60,000 |
| Total | 665,000 |

*Money statement.*

| | | |
|---|---|---|
| July 1, 1892, balance unexpended | | $6,914.41 |
| Amount appropriated by act approved July 13, 1892 | | 60,000.00 |
| | | 66,914.41 |
| June 30, 1893, amount expended during fiscal year | | 21,746.62 |
| July 1, 1893, balance unexpended | | 45,167.79 |
| July 1, 1893, outstanding liabilities | $584.28 | |
| July 1, 1893, amount covered by uncompleted contracts | 22,407.84 | |
| | | 22,992.12 |
| July 1, 1893, balance available | | 22,175.67 |
| Amount (estimated) required for completion of existing project | | 75,000.00 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895 | | 75,000.00 |

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

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### IMPROVEMENTS ABOVE VINCENNES.

Operations on this section of the river were limited to removing snags, the work being in progress from August 11 until the end of December, when the river froze; the length of river covered in these operations was 47 miles, in 31 of which the channel was entirely cleared of snags. The total number of snags removed and cut up was 688, with a total weight of about 3,870 tons. The navigable condition of this portion of the river (being about one-half of the distance from Vincennes, Ind. to Terre Haute, Ind.) was very much improved by this work, but from the point at which it was suspended up to Terre Haute the channel is still badly obstructed.

It is intended to resume this work as soon as the snag boat Osce has succeeded in clearing the lower portion of the White River, Indiana, on which she is now engaged.

An annual expenditure of about $5,000 will be necessary to keep this portion of the river free from snags. Besides this, channels should be dredged at several points, a few dams built to close secondary channels, and shore protection put in at several points from which large amounts of sand are annually washed into the river, supplying thereby the material by which the bars are formed. This is about all that could be done in the way of improvement unless an extensive system of work, whose cost would be out of all proportion with the present commerce of the river, should be undertaken. The cost of the work above suggested as being highly desirable is estimated at $20,000.

I transmit herewith the report of O. L. Petitdidier, assistant engineer, in immediate charge of these improvements, which includes the usual commercial statistics. These show that only three steamboats engaged in traffic on this portion of the river during the past year, carrying 7,873 tons of freight valued at $139,301, a falling off of 53,787 tons in amount and $1,068,090 in value as compared with the year before; this is attributed by river men to the very poor crops gathered last season from the lands bordering the upper Wabash.

The following is a summary of all appropriations made for the work to date:

| By the act— | |
|---|---|
| Approved March 3, 1881 | $25,000 |
| Approved August 2, 1882 | 30,000 |
| Approved July 5, 1884 | 10,000 |
| Of August 11, 1888 | 5,000 |
| By the act— | |
| Approved September 19, 1890 | $5,500 |
| Approved July 13, 1892 | 5,000 |
| Total | 80,500 |

*Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $4,767.98 |
| Amount appropriated by act approved July 13, 1892 | 5,000.00 |
| | 9,767.98 |
| June 30, 1893, amount expended during fiscal year | 7,505.64 |
| July 1, 1893, balance unexpended | 2,262.34 |
| July 1, 1893, outstanding liabilities | 6.85 |
| July 1, 1893, balance available | 2,255.49 |
| Amount (estimated) required for completion of existing project | 25,000.00 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895 | 25,000.00 |
| Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893. | |

### REPORT OF MR. O. L. PETITDIDIER, ASSISTANT ENGINEER.

MOUNT CARMEL, ILL., *June 30, 1893.*

COLONEL: I have the honor to present the following report of operations on the Wabash River below Vincennes, during the fiscal year ending June 30, 1893:

The work done has consisted of the reconstruction of snag boat *Osseo*, building new A frame for dredge, dredging foundation for west end of dam, quarrying stone for filling cribs and boating same to site of dam, inspecting and receiving timber for the dam; and, lastly, care of plant.

The work of reconstruction of the *Osseo*, which was in progress at beginning of fiscal year, was continued until completed October 4; this work consisted of rebuilding a new hull and upper works, using in the construction whatever portions of the old boat were found sound enough for the purpose.

A new steel boiler of larger dimensions was purchased and used in place of the old one, which was not only small but also weak.

The new boat is very well adapted to the work required, and draws only 18 inches of water at its lowest point.

The boat is now at work removing snags on the White River in place of the *Richard Ford*, which after fifteen years of service has become unfit for further snagging.

The wooden A frame of our dredge had become so decayed that it was thought best to replace it by a new one before any work of dredging was undertaken; this work was done at an expense of $100 for labor.

The dredge was put at work excavating sand, gravel, and débris, which overlaid the foundation of our dam. We were much hampered by the stage of water varying continually between wide limits, so that the work of the dredge could not be made complete, and will have to be supplemented by hand labor. The dredge worked some 35 days, removing 7,050 cubic yards of débris, at a total cost of very nearly $500.

The work of quarrying stone for the dam, which was contemplated if funds became available, was begun on October 18 and carried on through the winter until March 3, when the boating of stone from the quarry to the site of the dam (10 miles) was begun.

The boating of stone was done by means of our own boat and barges, assisted for a week or two by the steamers *Peankishaw* and *Irene* and their barges, and continued, off and on, as long as the stage of water permitted.

Enough stone was brought down to fill all the cribs of dam 1 or 2 feet above low water, and it is hoped that this backwater will be of great assistance to us in bringing the remainder of the stone.

The following data in regard to the stone are presented:

| | |
|---|---|
| Cubic yards of stone quarried | 9,085 |
| Cubic yards of stone brought from quarry to site of dam | 5,430 |
| Approximate cost of the same | $12,000.00 |
| Approximate cost of quarrying and piling, per cubic yard | 1.02 |
| Approximate cost of boating and unloading, per cubic yard | 0.50 |

The stone is a sandstone, rather soft, but still the best to be found within a radius of 10 miles. The cost of quarrying and boating this stone has run over my estimate, but this increase in the cost is due to the eight-hour law, which has increased the cost of our labor nearly 25 per cent.

The stone is now very close to the site of dam and will require but a short haul to put it in the cribs.

The timber to be used in the construction of the dam is being received every day and piled in the yard adjacent to the abutment; the amount of timber received to date is much below the amount required, but it is expected that this will increase very materially at once.

| | |
|---|---|
| Feet B. M. of timber received to July 1 | 113,412 |
| Feet B. M. of timber still required | 890,951 |

The care of plant has consisted of care of our fleet during the dull season, outfitting a plant at the quarry, and bringing same to our storehouse upon completion of work. Booms of derricks have been replaced and other minor repairs have also been made.

*Condition of the river*—The condition of the river below Vincennes remains unchanged since my last report, the work done having been confined to the dam and this being yet uncompleted, no benefit is expected until after completion of improvement.

The cut-off at New Harmony, reported previously as being such a drain on the main river, has steadily been increasing and is in a fair way to be the only channel of the river; no work has been contemplated at this place on account of the magnitude of the works which would be necessary.

The improvement at Grayville is still in good condition. The navigation of the river is, however, at a low ebb, but very little being done at low water. It will be seen by the commercial statistics here appended that a great falling off in the commerce has taken place during the last fiscal year, this being mainly due, I am informed, to the poor crops raised in the bottoms last season.

*Project.*—The work intended to be done consists of the construction of dam at Grand Rapids and completion of this improvement in so far as the funds on hand will allow.

The stone is now on hand or nearly so, the timber is being delivered daily, while the foundation for a good portion of the dam has been excavated.

It is intended to begin the work of construction of the dam in a very few days, and it is hoped to complete the dam by the end of the fall.

Owing to the eight-hour law, which has increased the cost of our labor nearly 25 per cent, it will not be possible to complete the improvement with the present funds on hand.

A bank protection below the dam next the abutment, guiding dikes in prolongation of lock walls, retaining walls above and below the lock, and some dredging will be necessary before the improvement is completed.

As in the present state of this improvement it is important that it be carried through to completion as far as the funds on hand will allow. No other work is proposed, unless additional funds become available.

I forward herewith the commercial statistics of the river for the past fiscal year, also comparative statistics for the last seven years.

Very respectfully submitted, your obedient servant,

O. L. PETITDIDIER,
*Assistant Engineer.*

Lieut. Col. G. J. LYDECKER,
*Corps of Engineers, U. S. A.*

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### COMMERCIAL STATISTICS.

*Statement of commerce, Wabash River, below Vincennes, for fiscal year ending June 30, 1893.*

| Articles. | Tons. | Approximate value. |
|---|---|---|
| Grain | 10,888 | $190,440.00 |
| Lumber and logs boated and rafted | 30,750 | 76,875.00 |
| Stone | 8,145 | 8,145.00 |
| Total | 49,783 | 275,460.00 |

*Comparative statement of commerce, Wabash River, above and below Vincennes.*

| Years. | Tons. | Approximate value. |
|---|---|---|
| 1887 | 122,729 | $1,817,947.00 |
| 1888 | 68,014 | 535,006.00 |
| 1889 | 106,513 | 1,573,698.00 |
| 1890 | 100,443 | 641,107.00 |
| 1891 | 103,415 | 1,162,209.00 |
| 1892 | 122,535 | 2,037,242.40 |
| 1893 | 57,656 | 414,761.00 |

*List of steamboats and barges plying on Wabash River, below Vincennes, during fiscal year ending June 30, 1893.*

| Name of boat. | Kind of boat. | Total tonnage. | Where plying. |
|---|---|---|---|
| Rosedale and 3 barges* | Stern-wheel | 561 | New Harmony and Ohio River. |
| Irene and 2 barges | ....do |  | Mount Carmel and White River to Grayville. |
| Peankishaw and 1 barge* | ....do |  | Vincennes to Grayville. |
| Emma Cooper and 5 barges* | ....do | 750 | New Harmony and Ohio River. |

*Make only occasional trips when the stage of water will permit.

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### REPORT OF MR. O. L. PETITDIDIER, ASSISTANT ENGINEER.

MOUNT CARMEL, ILL., *June 30, 1893.*

COLONEL: I have the honor to present the following report of operations on the Wabash River above Vincennes for the fiscal year ending June 30, 1893:

The project contemplated at the beginning of fiscal year consisted of removal of snags or other obstructions removable by means of the snag boat, and the reconstruction of snag boat *Osseo*, which was entirely beyond repair.

The snag boat *Osseo*, which it had been intended to use in removing snags, could not be completed in time to pass over the rapids a little above Mount Carmel, so that snagging was conducted by means of the snag boat *Richard Ford*, belonging to the

White River, this boat having been taken to Vincennes during high water and held in readiness there until the stage of water favorable for snagging had obtained.

The *Richard Ford* was put to work on August 10, 1892, and continued until forced to suspend by the ice.

The work accomplished by the boat has been considerable and is as follows:

| | |
|---|---|
| Days removing snags | 90 |
| Snags removed and cut up | [illegible] |
| Approximate weight of same in tons | 3,870 |
| Length of river operated upon—miles | 31 |

One-half the expense of rebuilding the *Osseo* was borne by the Wabash River above Vincennes, the other half by the Wabash River below Vincennes, and we are now in possession of a good snag boat, self-propelling and drawing only 18 inches of water.

It is intended to use this boat alternately on the Wabash River above and below Vincennes.

*Condition of the river.*—The condition of the river at low water has been much improved within the distance of 31 miles which was cleared out by the snag boat last summer and fall, but there are still many snags to be removed between Terre Haute and Hutsonville. and removal of snags will be necessary for several years to come as additional snags come in every year.

The commerce of the river has fallen off a great deal during last fiscal year; this is attributed by steamboat men to the very poor crops gathered last season in the bottom lands bordering the Wabash River.

*Project.*—It is intended to continue the removal of snags with the snag boat *Osseo* until the funds now on hand are exhausted. Should additional funds become available it is thought that no better work could be done than to continue the removal of snags.

The snag boat *Osseo*, which is now at work on the White River, can not, however, be taken up to Terre Haute until we have a rise sufficient to take the boat above the Grand Rapids near Mount Carmel.

I inclose commercial statistics showing the amount of commerce done during the last fiscal year.

Very respectfully submitted, your obedient servant,

O. L. PETITDIDIER,
*Assistant Engineer.*

Lieut. Col. G. J. LYDECKER,
*Corps of Engineers, U. S. A.*

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COMMERCIAL STATISTICS.

*Statement of commerce, Wabash River above Vincennes, for fiscal year ending June 30, 1893.*

| Articles. | Tons. | Approximate value. |
|---|---|---|
| Grain | 7,452 | [illegible] |
| Merchandise | 126 | [illegible] |
| Lumber and logs | 295 | 1,770.00 |
| Passengers, number 636, average fare $1 | | 636.00 |
| Total | 7,873 | [illegible] |

*List of steamboats and barges plying on Wabash River above Vincennes, during fiscal year ending June 30, 1893.*

| Name of boat. | Kind of boat. | Total tonnage. | Where plying. |
|---|---|---|---|
| Jenny Ray and 2 barges | Stern-wheel | 320 | Terre Haute and Vincennes. |
| Peankishaw and 1 barge | do | 129 | Do. |
| Diana and 2 barges | do | 110 | Russelville, Vincennes, and White River. |
| J. H. Russell | do | | Terre Haute and above. |

## G G 5.

### IMPROVEMENT OF WHITE RIVER, INDIANA.

The first appropriation for the improvement of this river was made by the act approved March 3, 1879, the object being to obtain a navigable channel with a minimum low-water depth of about 2 feet, which would permit navigation by boats drawing no more than 3 feet throughout most of the year. The work has consisted in the excavation of channels through rocky reefs and gravel shoals, the removal of snags and overhanging trees, the construction of dams and dikes for channel contraction, and the protection of banks where necessary. The principal obstruction originally was a long rocky reef known as Kellys Ripple, a short distance above the mouth of the river; a channel has been excavated through this reef with a clear width of 150 feet at its upper end, gradually narrowing to a uniform width of 75 feet for a length of about half a mile; the bottom of the channel is 3 feet below the plane of low water, and the material excavated was used to form lateral guiding dikes. In 1888 Congress directed that no further work be done on the river until certain bridges had been changed so as to no longer obstruct navigation, but this restriction was removed in 1890. In the following year the improvement of Kellys Ripple was completed, as stated above, but during the three years in which no work was done, channels that had been previously dredged had become filled up, the river had cut around behind some of the dikes and dams, leaving the piles used in their construction standing at some places in the new channels formed by such cutting, and the river throughout had become badly obstructed by snags. Such was its condition June 30, 1892.

It was intended to clear out the snags and other obstructions during the summer of 1892, but at the commencement of the season the snag boat *Richard Ford* was at work on the Wabash River, to which the White is tributary, a short distance above Vincennes, and continuous low water from that time until the following winter made it impossible to pass the intervening obstructions and do the work proposed; therefore it was not until the spring freshets subsided that it became practicable to do anything. Operations were finally commenced May 22, 1893, and favorable progress made up to the close of the fiscal year. The number of snags removed to June 30, 1893, was 183, weighing 915 tons, and 86 piles, which had originally been driven in building one of the dams, and had become a serious obstruction in the manner described above, were pulled out. The snag boat will continue at work throughout the ensuing season, and will probably succeed in clearing the river of such obstructions. After the snags have been cleared out it will be necessary to repair the dams and redredge some of the gravel bars in order to restore the river to the condition it was in before the suspension of work in 1888. An appropriation of $7,500 is recommended for this purpose.

The report of O. L. Petitdidier, assistant engineer, in immediate charge of this improvement, is transmitted herewith, from which it appears that last year's commerce aggregated only 9,393 tons, valued at $68,000, as compared with 23,130 tons, valued at $174,000, for the year before.

The following is a summary of all appropriations made for the work up to June 30, 1893:

| By the act— | | By the act— | |
|---|---|---|---|
| Approved March 3, 1879 | $25,000 | Approved August 5, 1886 | $7,500 |
| Approved June 14, 1880 | 20,000 | Of August 11, 1888 | 5,000 |
| Approved March 3, 1881 | 20,000 | Approved July 13, 1892 | 5,000 |
| Approved August, 2, 1882 | 20,000 | | |
| Approved July 5, 1884 | 10,000 | Total | 112,500 |

*Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $2,954.7 |
| Amount appropriated by act approved July 13, 1892 | 5,000.0 |
| | 7,954.7 |
| June 30, 1893, amount expended during fiscal year | 262.9 |
| July 1, 1893, balance unexpended | 7,691.8 |
| July 1, 1893, outstanding liabilities | 803.0 |
| July 1, 1893, balance available | 6,888.74 |
| Amount (estimated) required for completion of existing project | 7,500.00 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895 | 7,500.00 |

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

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### REPORT OF MR. O. L. PETITDIDIER, ASSISTANT ENGINEER.

MOUNT CARMEL, ILL., *June 30, 1893.*

COLONEL: I have the honor to present the following report upon the improvement of the White River, Indiana, for the fiscal year ending June 30, 1893:

The work contemplated consisted of removal of snags and other obstructions from the channel between the mouth of the river and forks, a distance of 45 miles.

The snag boat *Richard Ford*, which it had been intended to use for this work, was at work on the Wabash River above Vincennes during the early part of the fiscal year, and owing to the continuous low water could not be brought down to the White River until too late to do any work.

However, the snag boat *Osseo*, which had been rebuilt at Mount Carmel during last fall for the service of the upper and lower Wabash River, became available, and early during this spring this boat was sent up the White River to remove snags and other obstructions.

The *Osseo* began work on May 22, and is now at work near Hazleton, Ind.

The number of snags already removed is considerable; a row of piling which, owing to the cutting of the bank of the river, had become an obstruction much complained of, has been removed; other snags and obstructions are being removed daily wherever indicated by steamboat owners.

The work above is numerically as follows:

| | |
|---|---|
| Snags removed | 183 |
| Weight of same in tons | 91.5 |
| Number of piling removed | 86 |

*Condition of the river.*—The condition of the river has not changed very materially since my last report. The improvement at Kellys' Ripple, which has been of great benefit to the navigation, is still in good order; there has, however, been considerable benefit from the removal of snags and other obstructions now going on. As the funds on hand with which it is intended to continue snagging are still ample, it is expected that by the end of this season the majority of the snags will be removed between the mouth and the forks of the river.

The bridge at Rodgers is still unprovided with a draw, but it does not seem to cause any inconvenience.

*Project.*—It is intended to continue the work of removing snags as long as the funds on hand will allow. No other work is proposed, it being believed that for the present the navigation will be benefited the most by the means now employed.

I append the commercial statistics for the past fiscal year, also comparative statistics for the past seven years. I regret to say that there has been a decrease in the commerce of the river. The causes of this decrease are rather undefined; there seems to have been a greater scarcity of grain on hand at the time when stage of water was most favorable, and yet I begin to believe that this decrease may be due to the facilities for shipment by rail, which are increasing yearly, and it would seem that the shipment of grain by river route would soon cease, leaving for the river only the coarser commodities, such as logs, lumber, or coal, the freight on which would compose a great portion of their value.

The stage of water for the last four months has been very favorable, and yet the boats are tied up, doing nothing.

Very respectfully submitted, your obedient servant,

O. L. PETITDIDIER,
*Assistant Engineer.*

Lieut. Col. G. J. LYDECKER,
*Corps of Engineers, U. S. A.*

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COMMERCIAL STATISTICS.

*Statement of commerce, White River, Indiana, fiscal year ending June 30, 1893.*

| Articles. | Tons. | Approximate value. |
|---|---|---|
| Grain | 2,143 | $38,000 |
| Logs and lumber, boated and rafted | 7,250 | 30,000 |
| Total | 9,393 | 68,000 |

*Comparative statement of commerce, White River, Indiana.*

| Years. | Tons. | Approximate value. |
|---|---|---|
| 1887 | 12,650 | $181,000 |
| 1888 | 6,400 | 71,145 |
| 1889 | 27 000 | 137,950 |
| 1890 | 29,409 | 256,330 |
| 1891 | 15,632 | 93.150 |
| 1892 | 23,130 | 174,000 |
| 1893 | 9,393 | 68,000 |

*List of steamboats plying on White River, Indiana, during the fiscal year ending June 30, 1893.*

| Name. | Kind. | Total capacity. | Where plying, |
|---|---|---|---|
| | | *Tons.* | |
| Diana and 2 barges | Stern-wheel | 110 | Petersburg to Deckers. |
| Irene and 2 barges | do | 140 | Hazleton to Mount Carmel. |
| Peankishaw and 1 barge | do | 129 | Occasional trips. |
| Hugh Barr | do | 33 | Washington to Deckers, |

## G G 6.

## PRELIMINARY EXAMINATION OF LITTLE WABASH RIVER, ILLINOIS.

[Printed in House Ex. Doc. No. 163, Fifty-second Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
*Washington, D. C., January 5, 1893.*

SIR: I have the honor to submit the accompanying copy of report, dated December 22, 1892, by Lieut. Col. G. J. Lydecker, Corps of Engineers, of the results of a preliminary examination of Little Wabash

River, Illinois, made to comply with provisions of the river and harbor act approved July 13, 1892.

It is the opinion of Lieut. Col. Lydecker, concurred in by this office, that the river is not at this time worthy of improvement by the General Government.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
*Brig. Gen., Chief of Engineers.*

Hon. S. B. ELKINS,
*Secretary of War.*

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## REPORT OF LIEUT. COL. G. J. LYDECKER, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
*Louisville, Ky., December 22, 1892.*

GENERAL: I have the honor to submit the following report on a preliminary examination of the Little Wabash River, Illinois, made pursuant to instructions contained in Department letter of July 14, 1892.

This river, taking its rise in Shelby County, Ill., flows in a southerly direction, and empties into the Wabash River at a point about 50 miles above its mouth. Its total length is about 250 miles.

It is reported that in the year 1836 the State of Illinois declared this a navigable stream for a distance of about 180 miles from its mouth, and that its improvement was subsequently undertaken by the State, an appropriation of $35,000 having been made as late as 1868 to complete the construction of a lock and dam at New Haven, 2 miles above the mouth of the river. This work was duly completed in the following year, but it appears that the lock was kept in operation for about one year only; a few years later a portion of the dam was destroyed by fire, said to have been incendiary, and finally, in 1886, the dam was removed under a State appropriation.

The recent examination was confined to that portion of the river below the town of Carmi, about 26 miles above its mouth, at which point a milldam constitutes a complete obstruction to navigation; between this point and the mouth, 26 miles distant, the river is crossed by a wagon bridge without draw. The examination was made at extreme low water, such that it was not deemed advisable to attempt the trip in a rowboat; the stream was found to be shallow and sluggish, with occasional deep pools, a flow of about 35 feet per second, and a fall of 11 feet in 24 miles; the width is about 300 feet between banks, and the latter are generally high. Since 1870 there has been practically no commerce on the river, except that when the Wabash River is at a navigable stage boats ascend the Little Wabash about 2 miles to New Haven, and carry away the grain stored in that vicinity; the amount thus shipped within the past two years is reported to have been 135,000 bushels in 1890 and 120,000 bushels in 1891. Additional statistics as to the probable amount of commerce that might follow the improvement of the river were promised at the time of the examination by interested parties, but none have as yet been received, though several communications have since been sent to such parties asking that the promised information be furnished.

The above facts are summarized from the report of O. L. Petitdidier, assistant engineer, who made the examination, and whose report thereon is transmitted herewith, together with a blue-print sketch[*] of the stream from Carmi to the mouth.

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[*] Not printed.

After careful consideration of the facts presented I am of the opinion that the river is not, at this time, worthy of improvement by the General Government. Navigation on the main Wabash River is in its present condition very uncertain. When this is navigable boats can also ascend the Little Wabash as far as they would be likely to go to take on freight. It is probable that if the river were, at such times, navigable all the way up to Carmi, local freight rates might be slightly affected for the time being, but the takings of the railroads would leave an insignificant amount for river commerce. If, however, the contemplated improvement of the Lower Wabash should result in the establishment of any considerable *regular* traffic on that stream, the improvement of the Little Wabash in such way as to permit the extension of such regular traffic up to Carmi might then become a worthy undertaking by the General Government.

Very respectfully, your obedient servant,

G. J. LYDECKER,
*Lieut. Col., Corps of Engineers.*

Brig. Gen. THOMAS L. CASEY,
*Chief of Engineers, U. S. A.*

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### REPORT OF MR. O. L. PETITDIDIER, ASSISTANT ENGINEER.

MOUNT CARMEL, ILL., *November 25, 1892.*

COLONEL: I have the honor to present the following report on a preliminary examination of the Little Wabash River, Illinois, made on October 27, 28, and 29, 1892:

In compliance with your instructions, I proceeded on October 27, 1892, to Carmi, Ill., which town is located on the banks of the Little Wabash River about 26 miles from its mouth.

The Little Wabash River takes its rise in Shelby County, passing through Effingham, Clay, Wayne, and White counties, and empties into the Wabash River at a point 15 miles distant from its junction with the Ohio River, the total length of the Little Wabash River being about 250 miles. This stream was, in the early days, of some importance as an artery of commerce, and as early as the year 1836 the legislature of the State of Illinois declared the Little Wabash a navigable stream up to the northern boundary line of Clay County (this being about 180 miles from the mouth of the river).

No definite account of commerce done in the early days could be obtained, but there was evidently a demand for improvement, as, in the year 1868, an appropriation of $35,000 was granted by the State of Illinois to continue and complete the construction of a lock and dam which had been begun by a private corporation at New Haven, 2 miles from the mouth of the river.

This lock and dam were completed in 1869 and in use for one year, when, through some defect in the construction of the gates, these could no longer be opened, and navigation became suspended, the dam having thus become a complete barrier. This state of affairs lasted a few years, when a portion of the dam was destroyed by fire, it being evidently a case of incendiarism.

This gave some relief to the navigation, but not completely, so that in the year 1886 the Illinois State legislature passed an appropriation for the removal of dam, which was now useless and in the way.

Some 80 linear feet of the dam were removed in 1887, when the appropriation became exhausted. Such is, in brief, the history of the navigation on the Little Wabash River.

As a milldam in good order and of considerable importance was known to be in existence at Carmi, and as this dam is impassable to navigation, except at the highest stages of water, it was deemed unnecessary to make an examination of the Little Wabash River above Carmi. This report will, therefore, be confined to the portion of river between this point and the mouth of the river.

It had been my intention to examine the river in detail between Carmi and the mouth, by means of a rowboat, but the stage of water, which was then at its lowest, did not allow of it without entailing more time and expense than the funds allotted for the examination would warrant, so that this project was abandoned, and I confined myself to examining the river at Carmi, and thence by buggy to New Haven, 2 miles from mouth of river, stopping to take observations of the river whenever near enough to it.

At New Haven, where the old lock and dam are located, a thorough examination was made.

Starting at Carmi, about 26 miles from the mouth, I found a mill dam in good state of repair, clear across the river. This dam, with a lift of 10 feet, is built to produce a pool above Carmi, which supplies several sawmills with logs and which also supplies a 100-barrel flour mill with water-power for nine months of the year.

This dam is said to be over 50 years old. It has been rebuilt several times.

From Carmi down to the mouth the river, at low water, is usually shallow and sluggish, with here and there long, deep pools. The flow at time of examination did not exceed 30 to 35 cubic feet per second, while the fall between Carmi and New Haven, a distance of about 24 miles, is only 11 feet.

The banks of the river were found to be usually high and overflowed only at highest water.

The width of river between banks is 300 feet at Carmi, and this remains tolerably constant thence to the mouth.

Two bridges at Carmi and a third bridge 3 miles below complete the list of obstructions found until New Haven was reached.

At New Haven were found the ruins of the old lock and dam, photographs of which accompany this report.

As mentioned in the early portion of this report, the lock and dam were completed in 1869.

I was still able to ascertain the following dimensions of the former work, lock and dam being built on a foundation of sandstone rock: Dam, 24 feet wide, 17 feet high, with lift of 14 feet; lock chamber, 150 feet long between miter sills and 36 feet wide.

The lock and dam were both built of timbers framed in such a manner as to form internal compartments, which were filled with stone.

Some 17 acres of land abutting the lock are still owned by the State of Illinois.

When the dam was in working order the water was backed up a little over 2 feet deep at foot of milldam at Carmi, thus insuring at all times unimpeded navigation to the Wabash River, provided lock had been in good order.

*Commerce.*—There has been but little commerce done on the river since 1870, not only owing to the uselessness of the dam, but also owing to railroad competition.

The only commerce done at present is at and within a short distance of New Haven, where steamboats come every winter from the Wabash River and carry away the grain stored and waiting for transportation.

The amount of commerce reported as done by the principal shipper at New Haven, is as follows:

| | Bushels |
|---|---|
| Amount carried by river, 1890: | |
| Wheat | 80,000 |
| Corn | 55,000 |
| Amount carried by river, 1891: | |
| Wheat | 55,000 |
| Corn | 65,000 |

1892, in storage, 45,000 bushels wheat. Corn not yet gathered.

This is only a percentage of what might be done, as the surrounding country is most fertile and the area under cultivation is increasing rapidly.

Many additional statistics of the amount of commerce done at Carmi which might be carried by the river route were promised but have so far not been received.

It is an undoubted fact, however, of which I was well assured by the many business men interviewed at Carmi, that better shipping rates could be obtained from the two railroads at this place for the 250,000 bushels of grain shipped yearly were there a river outlet as an alternative.

*Conclusion.*—In conclusion, I would give it as my opinion that the Little Wabash River is worthy of improvement by the General Government, for the followng reasons:

(1) The commerce done under the present unfavorable conditions is not inconsiderable, and this would after improvement be much increased.

(2) There is a very general desire to see the improvement done.

(3) From an engineering standpoint the conditions of successful permanent improvement are very favorable.

(4) The possibility of improvement is beyond question, the experiment having been successful, barring the faulty location and construction of details of lock.

The following objections against the improvement have some weight:

(1) It is probable that were the dam rebuilt some of the lowlands adjoining the river would be submerged, and the question of indemnity might be a serious one.

(2) The possible insalubrity due to stagnant water.

(3) Presence of a wagon bridge below Carmi, which would require to be provided with a draw.

But the full force of these and other minor objections could only be ascertained through a survey, whereby the question of improvement can be discussed with a fuller knowledge than can be acquired by a first examination. Then can an approximate estimate of the total cost of improvement be made.

Very respectfully submitted.

Your obedient servant,

O. L. PETITDIDER,
*Assistant Engineer.*

Lieut. Col. G. J. LYDECKER,
*Corps of Engineers.*

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## G G 7.

## PRELIMINARY EXAMINATION OF EMBARRAS RIVER, ILLINOIS.

[Printed in House Ex. Doc. No. 162, Fifty-second Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
*Washington, D. C., January 5, 1893.*

SIR: I have the honor to submit the accompanying copy of report dated December 22, 1892, by Lieut. Col. G. J. Lydecker, Corps of Engineers, of the results of a preliminary examination of Embarras River, Illinois, made to comply with the requirements of the river and harbor act approved July 13, 1892.

It is the opinion of Lieut. Col. Lydecker that this river is not worthy of improvement by the General Government, and in this opinion I concur.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
*Brigadier-General, Chief of Engineers.*

Hon. S. B. ELKINS,
*Secretary of War.*

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### REPORT OF LIEUT. COL. G. J. LYDECKER, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
*Louisville, Ky., December 22, 1892.*

GENERAL: I have the honor to submit the following report on a preliminary examination of the Embarras River, Illinois, made pursuant to instructions contained in Department letter dated July 14, 1892.

This is a small stream rising in Champaign County, Ill., flowing in a southerly direction about 180 miles and emptying into the Wabash River a short distance below Vincennes, Ind. About 15 miles above the mouth of the river is the town of Lawrenceville, at which place is located a milldam, built some forty years ago. This section of the river, to which the examination was limited, is generally very shallow at low water, full of snags and sunken logs, crossed at one place by a barbed-wire fence, and spanned by five bridges without draws; its width is generally about 175 feet, that at the mouth being 250 feet; its low-water discharge is only 10 or 12 cubic feet per second, but at high water the stream has a rapid current and very considerable volume, the difference between high and low water being about 21 feet; the banks are generally low and at high water the stream overflows and widens out to from 1 to 11 miles. The only commerce on the stream is in the transportation of logs and lumber. Last year 1,500 logs were run out of the river at high water.

The improvement of this stream would be a matter of very considerable expense. There is at present no general commerce on it, nor is there anything to indicate that there would be any considerable amount of it if the stream should be improved. The country through which it flows is most liberally supplied with railroads, and it does not appear that there is any general demand for a river commerce. Considering the foregoing, it is my opinion that the stream is not worthy of improvement by the General Government.

I transmit herewith a blue-print sketch* of the river from its mouth to Lawrenceville, together with copy of report by O. L. Petitdidier, assistant engineer, who made the examination in person, which recites in more detail the facts on which my report is based.

Very respectfully, your obedient servant,

G. J. LYDECKER,
*Lieut. Col., Corps of Engineers.*

Brig. Gen. THOMAS L. CASEY,
*Chief of Engineers, U. S. A.*

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### REPORT OF MR. O. L. PETITDIDIER, ASSISTANT ENGINEER.

MOUNT CARMEL, ILL., *November 24, 1892.*

COLONEL: I have the honor to present the following report on a preliminary examination of the Embarras River, Illinois:

In compliance with your instructions I proceeded on October 25, 1892, to Lawrenceville, Ill., this being the first town above the mouth of the Embarras River, and where it was expected the most information in regard to the river might be obtained.

The Embarras River takes its rise in Champaign County and passes through Douglas, Coles, Cumberland, Jasper, Crawford, and Lawrence counties, its length being about 180 miles. The river is 250 feet wide at its mouth, and averages 175 to 200 feet wide at Lawrenceville; the discharge at low water is very small, possibly not exceeding 10 cubic feet per second at Lawrenceville, but during high water the current is very swift, and the river overflows its banks some 4 feet, there being between high and low water a difference of about 21 feet.

There is an old milldam at Lawrenceville which prevents any communication between the upper and lower part of the river except at highest stage of water. This dam, which was built forty years ago and repaired from time to time, is now in a bad state of repair and may possibly be removed in a short time. This dam is about 300 feet long, 8 feet high, and in its present condition and at low water raises the level of pool 3 feet.

Upon inspection of this dam it was concluded that an examination of the river above Lawrenceville would be useless, as unless communication could be secured with the Wabash River the improvement of the stream could not well come within the province of the General Government. My examination was then confined to the portion of the river between Lawrenceville and the mouth, a distance of 15 miles.

This examination was made by the aid of a rowboat. The river for the first 10 to 12 miles was found to be very shallow, often having less than 6 inches of water, full of snags and sunken logs, and on one occasion completely barred with drift, involving half an hour's work to pass through, while on many occasions wading had to be resorted to. At another place a barbed-wire fence was stretched across the river. A few rock shoals were also met with. Three miles above the mouth of the river the ruins of an old stone dam were seen. At this point a fall of 15 inches was noted. The 2½ or 3 miles of river next to the mouth were found to be deeper and freer from snags. The river banks were often cutting and caving and everywhere comparatively low, about 16 feet in height above low water, and I was informed that at high water these were overflowed to a depth of 4 to 6 feet, the water spreading out from 1 to 11 miles in width. When starting from Lawrenceville I had provided myself with a copy of the county map showing the river, but after losing sight of town it became impossible to recognize one's surroundings, as the river is certainly much more tortuous than is shown by the map. Two bridges at Lawrenceville and three bridges between Lawrenceville and the mouth were found, all of which were unprovided with draws. These bridges are shown on the accompanying map.

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*Not printed.

*Commerce.*—The commerce between Lawrenceville and the mouth of the river consists only of rafts of logs which go out at high water. Fifteen hundred logs went out last year. The Wabash River boats never come up to Lawrenceville for the reason that when the water is high they can not pass under the bridges.

The commerce above Lawrenceville is, however, considerable, but it is all done in the interest of one or two sawmills owned by the H. G. Fink Manufacturing Company. This firm has constructed a small steamboat and a barge, which they operate between the dam at Lawrenceville and points above, and bring down rafts of logs and sawed lumber from their upper mill when stage of water is suitable. The lumber is thence shipped by rail to Chicago, St. Louis, Indianapolis, and even to England.

Mr. Ward, the manager at Lawrenceville for H. G. Fink & Co., informed me that they can run their boat six months every year. Eight million staves and 3,000,000 feet of lumber were handled by this firm last year.

In concluding my report I would say that, in my opinion, this river is not worthy of improvement by the General Government for the following reasons:

(1) The presence of five bridges unprovided with draws within a distance of 15 miles from mouth of river.

(2) The presence of a dam at Lawrenceville.

(3) Very small discharge at low water, thus necessitating a project of slack-water navigation in order to obtain improvement.

(4) Great expense not only of slack-water navigation but also to provide the existing bridges with draws and for payment for submerged lands.

(5) The prospective commerce on the portion of the river improved would not, in my opinion and that of others who have been interviewed, be increased.

As well as I could ascertain there is no demand for improvement of the river below Lawrenceville.

Improvement of the river above that point would undoubtedly be of local benefit, but this has not been considered.

Very respectfully submitted.

Your obedient servant,

O. L. PETITDIDIER,
*Assistant Engineer.*

Lieut. Col. G. J. LYDECKER,
*Corps of Engineers.*

# APPENDIX H H.

## IMPROVEMENT OF GREAT KANAWHA, ELK, AND GAULEY RIVERS, WEST VIRGINIA, AND OF NEW RIVER, VIRGINIA AND WEST VIRGINIA.

*REPORT OF COLONEL WILLIAM P. CRAIGHILL, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1893.*

### IMPROVEMENTS.

1. Great Kanawha River, West Virginia.
2. Operating and care of locks and dams on Great Kanawha River, West Virginia.
3. Elk River, West Virginia.
4. Gauley River, West Virginia.
5. New River, Virginia and West Virginia.

(For letter of transmittal see Appendix I.)

## H H 1.

### IMPROVEMENT OF GREAT KANAWHA RIVER, WEST VIRGINIA.

The object of the improvement has been to give a depth of not less than 6 feet all the year round throughout the whole river, 96 miles. The means are locks and dams. The locks are about 300 by 50 feet above Charleston, and about 340 by 55 feet below. The following table shows the present condition:

| No. | Distance from Charleston. | Style of dam. | Completed in— | Remarks. |
|---|---|---|---|---|
| 2 | 26 miles above | Fixed | 1887 | In operation. |
| 3 | 21 miles above | do | 1882 | Do. |
| 4 | 15 miles above | Movable | 1880 | Do. |
| 5 | 9 miles above | do | 1880 | Do. |
| 6 | 4 miles below | do | 1886 | Do. |
| 7 | 14 miles below | do |  | Will be in operation in 1893. |
| 8 | 22½ miles below | do |  | Do. |
| 9 | 32 miles below | do |  | Under contract for completion. |
| 10 | 39½ miles below | do |  | Do. |
| 11 | 56½ miles below | do |  | Do. |

Some dredging is also necessary in some of the pools, as well as the occasional removal of snags and rocks.

Locks and dams 7 and 8 are essentially completed. Their use will be a very great gain in the navigation of the river at all seasons of the year.

Mr. A. M. Scott has continued to exercise the local charge in his usual efficient manner. His report, which is appended, treats in detail of the operations of the year.

As the improvement of the river has progressed the commerce on it, notably the shipment of coal, has greatly increased.

The telephone line has been maintained between the central office in Charleston and the locks, and it is used by night as well as by day, being found indispensable for the proper oversight and direction of the operations, as well of construction and of maintenance.

A gauge reader has been kept at Kanawha Falls, near which place the Gauley joins the New to form the Great Kanawha River, and another at Hinton, where the Greenbrier empties into the New River. The compensation of these men is less than $10 a month each. They send to the central office daily reports, by postal card, of the stage of the river at their respective stations and by telegraph when there is a rapid rise. These reports are necessary as warnings to the central office in Charleston, in order that such maneuvers of dams, etc., may be had in time as the height and duration of the freshet may require.

For perfect security a similar station should be occupied at some point on the upper Gauley, and perhaps also on the Elk.

The following are the amounts and dates of appropriations for improving Great Kanawha River, West Virginia:

| | | | |
|---|---:|---|---:|
| March, 3, 1873 | $25,000 | July 5, 1884 | $200,000 |
| June 23, 1874 | 25,000 | August 5, 1886 | 187,500 |
| March 3, 1875 | 300,000 | August 11, 1888 | 350,000 |
| August 14, 1876 | 270,000 | September 19, 1890 | 300,000 |
| June 18, 1878 | 222,000 | July 13, 1892 | 225,000 |
| March 3, 1879 | 150,000 | March 3, 1893 | 500,000 |
| June 14, 1880 | 200,000 | | |
| March 3, 1881 | 200,000 | Total | 3,354,500 |
| August 2, 1882 | 200,000 | | |

*Money statement.*

| | | |
|---|---:|---:|
| July 1, 1892, balance unexpended | | $207,900.02 |
| Amount appropriated by act approved July 13, 1892 | | 225,000.00 |
| Amount appropriated by sundry civil act approved March 3, 1893 | | 500,000.00 |
| | | 932,900.02 |
| June 30, 1893, amount expended during fiscal year | | 201,923.26 |
| July 1, 1893, balance unexpended | | 730,976.76 |
| July 1, 1893, outstanding liabilities | $4,000.00 | |
| July 1, 1893, amount covered by uncompleted contracts | 1,078,742.04 | |
| | | 1,082,742.04 |
| Amount (estimated) required for completion of existing project<br>Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867. | | 580,700.00 |

*Abstract of proposals for ironwork for gates of Locks Nos. 7 and 8, Great Kanawha River improvement, opened at the U. S. Engineer Office, Charleston, W. Va., at 3 p. m., August 24, 1892.*

| | Approximate quantities. | No. 1.—H. T. Morrison & Co., Petersburg, Va. | | No. 2.—Weimer Machine Works Co., Lebanon, Pa. | | No. 3.—Scaife Foundry and Machine Co., Pittsburg, Pa. | |
|---|---|---|---|---|---|---|---|
| | | Bid. | Amount. | Bid. | Amount. | Bid. | Amount. |
| | *Pounds.* | *Cents.* | | *Cents.* | | *Cents.* | |
| Wrought iron | 92,000 | $5\frac{23}{100}$ | $4,811.60 | $5\frac{23}{100}$ | $4,811.60 | $6\frac{1}{2}$ | $5,980.00 |
| Cast iron | 57,000 | $3\frac{65}{100}$ | 2,080.50 | $4\frac{48}{100}$ | 2,553.60 | $4\frac{3}{4}$ | 2,707.50 |
| Steel | 3,500 | $7\frac{1}{2}$ | 262.50 | 21 | 735.00 | 16 | 560.00 |
| Bronze | 550 | 38 | 209.00 | 35 | 192.50 | 25 | 137.50 |
| **Total** | | | 7,363.60 | | 8,292.70 | | 9,385.00 |

**Bids rejected for noncompliance with the eight-hour law.**

*Abstract of proposals for ironwork for gates of Locks Nos. 7 and 8, Great Kanawha River improvement, opened at the U. S. Engineer Office, Charleston, W. Va., at 3 p. m., October 19, 1892.*

| | Approximate quantities. | No. 1.—Weimer Machine Works Co., Lebanon, Pa. | | No. 2.—H. T. Morrison & Co., Petersburg, Va. | | No. 3.—Thomas Carlins' Sons, Allegheny, Pa. | | No. 4.—Lambert Brothers & Co., Ironton, Ohio. | |
|---|---|---|---|---|---|---|---|---|---|
| | | Bid. | Amount. | Bid. | Amount. | Bid. | Amount. | Bid. | Amount. |
| | *Lbs.* | *Cts.* | | *Cts.* | | *Cts.* | | *Cts.* | |
| Wrought iron | 92,000 | $5\frac{2}{10}$ | $4,784.00 | $5\frac{23}{100}$ | $4,811.60 | $5\frac{78}{100}$ | $5,317.60 | $5\frac{35}{100}$ | $4,922.00 |
| Cast iron | 57,000 | $4\frac{1}{10}$ | 2,337.00 | $3\frac{65}{100}$ | 2,080.50 | $4\frac{69}{100}$ | 2,673.30 | $5\frac{85}{100}$ | 3,334.50 |
| Steel | 3,500 | 15 | 525.00 | $7\frac{1}{2}$ | 262.50 | $19\frac{24}{100}$ | 673.40 | 11 | 385.00 |
| Bronze | 550 | 30 | 165.00 | 38 | 209.00 | 30 | 165.00 | $26\frac{85}{100}$ | 147.67 |
| **Totals** | | | 7,811.00 | | 7,363.60 | | 8,829.30 | | 8,789.17 |

**Contract with H. T. Morrison & Co.**

*Abstract of proposals for building Lock and Dam No. 9, Great Kanawha River improvement, opened at Charleston-Kanawha, W. Va., at 3:05 p. m., February 16, 1893.*

| Kind of work. | Approximate quantities. | No. 1.—Humphrey Devereux, Shawneetown, Ill. |  | No. 2.—Zimmerman, Truax & Sheridan, Duluth, Minn. |  | No. 3.—Carkin, Stickney & Cram, East Saginaw, Mich. |  |
|---|---|---|---|---|---|---|---|
|  |  | Bid. | Amount. | Bid. | Amount. | Bid. | Amount. |
| Grubbing and clearing complete |  | $300.00 | $300.00 | $500.00 | $500.00 | $800.00 | $800.00 |
| Crib logs in Cofferdam l. ft. | 140,000 | .20 | 28,000.00 | .17 | 23,800.00 | .20 | 28,000.00 |
| Sheathing B. M. | 93,000 | 30.00 | 2,790.00 | 25.00 | 2,325.00 | 25.00 | 2,325.00 |
| Cofferdam filling cub. yds. | 21,500 | .85 | 18,275.00 | .65 | 13,975.00 | .60 | 12,900.00 |
| Excavation do. | 44,000 | .75 | 33,000.00 | .80 | 35,200.00 | 1.10 | 48,400.00 |
| Excavation, rock do. | 800 | 2.00 | 1,600.00 | 2.00 | 1,600.00 | 5.00 | 4,000.00 |
| Embankment do. | 10,500 | .40 | 4,200.00 | .55 | 5,775.00 | .80 | 8,400.00 |
| Puddling do. | 1,300 | 1.50 | 1,950.00 | 2.00 | 2,600.00 | 3.00 | 3,900.00 |
| Concrete do. | 2,500 | 7.00 | 17,500.00 | 6.75 | 16,875.00 | 8.00 | 20,000.00 |
| Backing masonry do. | 5,950 | 8.00 | 47,600.00 | 9.00 | 53,550.00 | 10.00 | 59,500.00 |
| Rock-face masonry do. | 2,970 | 11.00 | 32,670.00 | 11.00 | 32,670.00 | 10.50 | 31,185.00 |
| Pointed-face masonry do. | 2,200 | 12.50 | 27,500.00 | 13.00 | 28,600.00 | 12.00 | 26,400.00 |
| Cut-stone masonry do. | 450 | 22.00 | 9,900.00 | 18.00 | 8,100.00 | 14.00 | 6,300.00 |
| Sills do. | 520 | 22.00 | 11,440.00 | 17.00 | 8,840.00 | 20.00 | 10,400.00 |
| Quoins do. | 76 | 22.00 | 1,672.00 | 24.00 | 1,824.00 | 25.00 | 1,900.00 |
| Coping do. | 870 | 22.00 | 19,140.00 | 18.00 | 15,660.00 | 25.00 | 21,750.00 |
| Stone filling do. | 4,200 | 1.50 | 6,300.00 | 2.00 | 8,400.00 | 1.50 | 6,300.00 |
| Riprap, hand-placed do. | 3,000 | 3.00 | 9,000.00 | 3.00 | 9,000.00 | 3.00 | 9,000.00 |
| Paving do. | 1,100 | 5.00 | 5,500.00 | 5.00 | 5,500.00 | 6.00 | 6,600.00 |
| Timber in permanent construction feet B. M. | 165,000 | 45.00 | 7,425.00 | 40.00 | 6,600.00 | 75.00 | 12,375.00 |
| Bolt holes in masonry l. ft. | 65,000 | .30 | 1,950.00 | .30 | 1,950.00 | .30 | 1,950.00 |
| Total |  |  | 287,712.00 |  | 283,344.00 |  | 322,185.00 |

| Kind of work. | Approximate quantities. | No. 4.—Harrold & McDonald, Pittsburg, Pa. |  | No. 5.—Thos. Munford, Lock No. 7, West Virginia. |  | No. 6.—Joseph Gianini, Allegheny City, Pa. |  |
|---|---|---|---|---|---|---|---|
|  |  | Bid. | Amount. | Bid. | Amount. | Bid. | Amount. |
| Grubbing and clearing complete |  | $500.00 | $500.00 | $1,000.00 | $1,000.00 | $100.00 | $100.00 |
| Crib logs in cofferdam l. ft. | 140,000 | .20 | 28,000.00 | .25 | 35,000.00 | .21 | 29,400.00 |
| Sheathing feet B. M. | 93,000 | 35.00 | 3,255.00 | 30.00 | 2,790.00 | 31.00 | 2,883.00 |
| Cofferdam filling cub. yd. | 21,500 | 1.25 | 26,875.00 | .50 | 10,750.00 | 1.99 | 42,785.00 |
| Excavation do. | 44,000 | .75 | 33,000.00 | .90 | 39,600.00 | .70 | 30,800.00 |
| Excavation, rock do. | 800 | 4.00 | 3,200.00 | 4.00 | 3,200.00 | 3.00 | 2,400.00 |
| Embankment do. | 10,500 | .70 | 7,350.00 | .65 | 6,825.00 | .70 | 7,350.00 |
| Puddling do. | 1,300 | 3.50 | 4,550.00 | 4.00 | 5,200.00 | 3.00 | 3,900.00 |
| Concrete do. | 2,500 | 8.50 | 21,250.00 | 7.25 | 18,125.00 | 7.75 | 19,375.00 |
| Backing masonry do. | 5,950 | 10.00 | 59,500.00 | 9.00 | 53,550.00 | 9.50 | 56,525.00 |
| Rock-face masonry do. | 2,970 | 10.50 | 31,185.00 | 10.00 | 29,700.00 | 11.50 | 34,155.00 |
| Pointed-face masonry do. | 2,200 | 14.00 | 30,800.00 | 11.50 | 25,300.00 | 13.75 | 30,250.00 |
| Cut-stone masonry do. | 450 | 19.00 | 8,550.00 | 15.00 | 6,750.00 | 19.00 | 8,550.00 |
| Sills do. | 520 | 19.00 | 9,880.00 | 18.00 | 9,360.00 | 19.00 | 9,880.00 |
| Quoins do. | 76 | 25.00 | 1,900.00 | 25.00 | 1,900.00 | 19.00 | 1,444.00 |
| Coping do. | 870 | 22.00 | 19,140.00 | 20.00 | 17,400.00 | 18.00 | 15,660.00 |
| Stone filling do. | 4,200 | 1.50 | 6,300.00 | 1.25 | 5,250.00 | 1.70 | 7,140.00 |
| Riprap, hand-placed do. | 3,000 | 2.50 | 7,500.00 | 2.20 | 6,600.00 | 3.00 | 9,000.00 |
| Paving do. | 1,100 | 5.00 | 5,500.00 | 5.00 | 5,500.00 | 5.00 | 5,500.00 |
| Timber in permanent construction feet B. M. | 165,000 | 75.00 | 12,375.00 | 60.00 | 9,900.00 | 60.00 | 9,900.00 |
| Bolt holes in masonry l. ft. | 65,000 | .30 | 1,950.00 | .50 | 30,250.00 | .35 | 2,275.00 |
| Total |  |  | 322,560.00 |  | 296,950.00 |  | 329,272.00 |

**Contract with Zimmerman, Truax & Sheridan.**

*Abstract of proposals for building Lock and Dam No. 10, Great Kanawha River improvement, opened at Charleston-Kanawha, W. Va., at 3:05 p. m., February 23, 1893.*

| Kind of work. | Approximate quantities. | No. 1.—Humphrey Devereux, Shawneetown, Ill. | | No. 2.—Jos. Gianini, Allegheny City, Pa. | | No. 3.—Zimmerman, Truax & Sheridan, Duluth, Minn. | |
|---|---|---|---|---|---|---|---|
| | | Bid. | Amount. | Bid. | Amount. | Bid. | Amount. |
| Grubbing and clearing complete | .......... | $500.00 | $500.00 | $500.00 | $500.00 | $500.00 | $500.00 |
| Crib logs in cofferdam .. l. ft.. | 110,000 | .20 | 22,000.00 | .20 | 22,000.00 | .20 | 22,000.00 |
| Sheathing ........ feet. B. M.. | 70,000 | 30.00 | 2,100.00 | 31.00 | 2,170.00 | 30.00 | 2,100.00 |
| Cofferdam filling .. cub. yds .. | 15,500 | 1.00 | 15,500.00 | 1.50 | 23,250.00 | .90 | 13,950.00 |
| Excavation ............ do.... | 28,000 | .85 | 23,800.00 | .75 | 21,000.00 | .95 | 26,600.00 |
| Excavation, rock ...... do.... | 2,600 | 3.00 | 7,800.00 | 3.75 | 9,750.00 | 2.00 | 5,200.00 |
| Embankment .......... do.... | 10,000 | .40 | 4,000.00 | .75 | 7,500.00 | .80 | 8,000.00 |
| Puddling .............. do.... | 350 | 1.50 | 525.00 | 3.00 | 1,050.00 | 2.00 | 700.00 |
| Concrete .............. do.... | 1,400 | 7.00 | 9,800.00 | 7.70 | 10,780.00 | 7.50 | 10,500.00 |
| Backing masonry ...... do.... | 4,250 | 8.00 | 34,000.00 | 9.00 | 38,250.00 | 9.00 | 38,250.00 |
| Rock-face masonry .... do.... | 1,550 | 11.50 | 17,825.00 | 11.00 | 17,050.00 | 12.00 | 18,600.00 |
| Pointed-face masonry .. do.... | 2,050 | 12.50 | 25,625.00 | 13.50 | 27,675.00 | 15.00 | 30,750.00 |
| Cut-stone masonry .... do.... | 412 | 22.00 | 9,064.00 | 20.00 | 8,240.00 | 20.00 | 8,240.00 |
| Sills .................. do.... | 525 | 22.00 | 11,550.00 | 18.00 | 9,450.00 | 20.00 | 10,500.00 |
| Quoins ................ do.... | 72 | 22.00 | 1,584.00 | 22.00 | 1,584.00 | 25.00 | 1,800.00 |
| Coping ................ do.... | 870 | 22.00 | 19,140.00 | 18.00 | 15,660.00 | 20.00 | 17,400.00 |
| Stone filling .......... do.... | 3,400 | 1.50 | 5,100.00 | 1.75 | 5,950.00 | 2.00 | 6,800.00 |
| Riprap, hand placed ... do.... | 2,600 | 3.00 | 7,800.00 | 3.00 | 7,800.00 | 2.50 | 6,500.00 |
| Paving ................ do.... | 900 | 5.00 | 4,500.00 | 5.00 | 4,500.00 | 5.50 | 4.950.00 |
| Timber in permanent construction ....... feet, B. M.. | 132,000 | 40.00 | 5,280.00 | 55.00 | 7,260.00 | 50.00 | 6,600.00 |
| Bolt holes in masonry .. l. ft.. | 6,400 | .40 | 2.560.00 | .30 | 1,920.00 | .40 | 2,560.00 |
| Total ................. | .......... | ........ | 230,053.00 | ........ | 243,339.00 | ........ | 242,500.00 |

| Kind of work. | Approximate quantities. | No. 4.—Harrold & McDonald, Pittsburg, Pa. | | No. 5.—Thos. Munford, Lock No. 7, West Virginia. | | No. 6.—Carkin, Stickney & Cram, East Saginaw, Mich. | |
|---|---|---|---|---|---|---|---|
| | | Bid. | Amount. | Bid. | Amount. | Bid. | Amount. |
| Grubbing and clearing complete | .......... | $500.00 | $500.00 | $1,000.00 | $1,000.00 | $200.00 | $200.00 |
| Crib logs in cofferdam .. l. ft.. | 110,00 | .20 | 22,000.00 | .25 | 27,500.00 | .20 | 22,000.00 |
| Sheathing ........ feet, B. M.. | 70,000 | 35.00 | 2,450.00 | 30.00 | 2,100.00 | 25.00 | 1,750.00 |
| Coffer-dam filling .... cub. ft.. | 15,500 | 1.60 | 24,800.00 | 1.00 | 15,500.00 | 1.50 | 23,250.00 |
| Excavation ............ do.... | 28,000 | .75 | 2.100.00 | 1.00 | 28,000.00 | 1.10 | 30,800.00 |
| Excavation, rock ....... do.... | 2,600 | 3.50 | 9,100.00 | 3.50 | 9,100.00 | 4.00 | 10,400.00 |
| Embankment .......... do.... | 10,000 | .70 | 7,000.00 | .70 | 7,000.00 | .65 | 6.500.00 |
| Puddling .............. do.... | 350 | 3.50 | 1,225.00 | 3.00 | 1,050.00 | 2.50 | 875.00 |
| Concrete .............. do.... | 1,400 | 8.00 | 11,200.00 | 7.25 | 10,150.00 | 7.00 | 9,800.00 |
| Backing masonry ...... do.... | 4,250 | 10.00 | 42,500.00 | 9.00 | 38,250.00 | 9.00 | 38,250.00 |
| Rock-face masonry .... do ... | 1,550 | 10.00 | 15,500.00 | 10.50 | 16,275.00 | 11.00 | 17,050.00 |
| Pointed-face masonry .. do.... | 2,050 | 13.00 | 26,650.00 | 13.00 | 26,650.00 | 14.00 | 28,700.00 |
| Cut-stone masonry .... do.... | 412 | 18.00 | 7,196.00 | 18.00 | 7.416.00 | 15.00 | 6.180.00 |
| Sills .................. do.... | 525 | 18.00 | 9,450.00 | 18.00 | 9,450.00 | 20.00 | 10,500.00 |
| Quoins ................ do.... | 72 | 25.00 | 1,800.00 | 24.00 | 1,728.00 | 25.00 | 1,800.00 |
| Coping ................ do.... | 870 | 20.00 | 17,400.00 | 20.00 | 17,400.00 | 18.00 | 15,660.00 |
| Stone filling ........ ... do.... | 3,400 | 1.50 | 5,100.00 | 1.50 | 5,100.00 | 1.50 | 5,100.00 |
| Riprap, hand-placed ... do.... | 2,600 | 2.65 | 6,890.00 | 2.75 | 7,150.00 | 3.00 | 7,800.00 |
| Paving ................ do.... | 900 | 4.75 | 4,275.00 | 5.00 | 4,500.00 | 5.00 | 4,500.00 |
| Timber in permanent construction ...... feet, B. M... | 132,000 | 70.00 | 9,240.00 | 50.00 | 6,600.00 | 75.00 | 9,900.00 |
| Bolt holes in masonry .. l. ft.. | 6,400 | .30 | 1,920.00 | .40 | 2,560.00 | .50 | 3,200,00 |
| Total ................. | .......... | ........ | 247,416.00 | .......... | 244,479.00 | ........ | 254,215.00 |

Bids rejected and work readvertised.

*Abstract of proposals for building Lock and Dam No. 11, Great Kanawha River improvement, opened at Charleston-Kanawha, W. Va., at 3 p. m, March 2, 1893.*

| Kind of work. | Approximate quantities. | No. 1.—Humphrey Devereux, Shawneetown, Ill. |  | No. 2.—Harrold & McDonald, Pittsburg, Pa. |  | No. 3.—Giannini, Foley & Theis, Pittsburg, Pa. |  |
|---|---|---|---|---|---|---|---|
|  |  | Bid. | Amount. | Bid. | Amount. | Bid. | Amount. |
| Grubbing and clearing complete | .......... | $100.00 | $100 | $1,000.00 | $1,000 | $1,000.00 | $1,000 |
| Crib logs in cofferdam....l. ft.. | 215,000 | .20 | 43,000 | .20 | 43,000 | .21 | 45,150 |
| Sheathing..........feet, B. M.. | 120,000 | 30.00 | 3,600 | 35.00 | 4,200 | 35.00 | 4,200 |
| Cofferdam filling...cubic yds.. | 33,000 | .80 | 26,400 | .80 | 26,400 | 2.00 | 66,000 |
| Common excavation......do.... | 130,000 | .60 | 78,000 | .70 | 91,000 | 1.50 | 195,000 |
| Hard-pan excavation.....do.... | 5,000 | 3.00 | 15,000 | 2.00 | 10,000 | 2.00 | 10,000 |
| Rock excavation.........do.... | 100 | 3.00 | 300 | 5.00 | 500 | 3.00 | 300 |
| Embankment............do.... | 14,000 | .40 | 5,600 | .70 | 9,800 | .70 | 9,800 |
| Puddling................do.... | 1,600 | 1.50 | 2,400 | 3.50 | 5,600 | 3.00 | 4,800 |
| Concrete................do.... | 13,000 | 6.50 | 84,500 | 7.50 | 97,500 | 7.50 | 97,500 |
| Backing masonry........do.... | 5,300 | 8.00 | 42,400 | 9.00 | 47,700 | 9.50 | 50,350 |
| Rock-face masonry......do.... | 3,000 | 11.50 | 34,500 | 10.00 | 30,000 | 11.00 | 33,000 |
| Pointed face masonry....do.... | 2,450 | 12.50 | 30,625 | 12.00 | 29,400 | 13.50 | 33,075 |
| Cut-stone masonry......do.... | 650 | 22.00 | 14,300 | 17.00 | 11,050 | 18.50 | 12,025 |
| Sills....................do.... | 590 | 22.00 | 12,980 | 17.00 | 10,030 | 18.50 | 10,915 |
| Quoins..................do.... | 80 | 22.00 | 1,760 | 22.00 | 1,760 | 20.50 | 1,640 |
| Coping..................do.... | 970 | 22.00 | 21,340 | 18.00 | 17,460 | 18.50 | 17,945 |
| Stone filling............do.... | 12,000 | 1.50 | 18,000 | 1.40 | 16,800 | 2.00 | 24,000 |
| Riprap, hand-placed.....do.... | 2,800 | 3.00 | 8,400 | 2.25 | 6,300 | 3.50 | 9,800 |
| Paving..................do.... | 1,500 | 5.00 | 7,500 | 5.00 | 7,500 | 5.50 | 8,250 |
| Timber in permanent construction...............feet, B. M. | 800,000 | 45.00 | 36,000 | 50.00 | 40,000 | 55.00 | 44,000 |
| Permanent piles....linear feet. | 1,000 | .30 | 300 | .40 | 400 | .90 | 900 |
| Bolt holes in masonry....do.... | 4,300 | .40 | 1,720 | .30 | 1,290 | .40 | 1,720 |
| Total.................. | .......... | .......... | 486,725 | .......... | 508,690 | .......... | 681,370 |

| Kind of work. | Approximate quantities. | No. 4.—Zimmerman, Truax & Sheridan, Duluth, Minn. |  | No. 5.—Carkin, Stickney & Cram, East Saginaw, Mich. |  |
|---|---|---|---|---|---|
|  |  | Bid. | Amount. | Bid. | Amount. |
| Grubbing and clearing, complete.............. | .......... | $1,000.00 | $1,000 | $1,000.00 | $1,000 |
| Crib logs in cofferdam.............linear feet.. | 215,000 | .25 | 53,750 | .30 | 64,500 |
| Sheathing..........................feet, B. M.. | 120,000 | 30.00 | 3,600 | 30.00 | 3,600 |
| Coffer-dam filling................cubic yards.. | 33,000 | .80 | 26,400 | 1.35 | 44,550 |
| Common excavation......................do.... | 130,000 | 1.11 | 144,300 | 1.00 | 130,000 |
| Hard-pan excavation......................do.... | 5,000 | 2.00 | 10,000 | 2.00 | 10,000 |
| Rock excavation..........................do.... | 100 | 1.00 | 100 | 4.00 | 400 |
| Embankment...............................do.... | 14,000 | .50 | 7,000 | .75 | 10,500 |
| Puddling..................................do.... | 1,600 | 2.00 | 3,200 | 3.50 | 5,600 |
| Concrete..................................do.... | 13,000 | 7.00 | 91,000 | 7.25 | 94,250 |
| Backing masonry..........................do.... | 5,300 | 8.00 | 42,400 | 8.50 | 45,050 |
| Rock-face masonry........................do.... | 3,000 | 11.00 | 33,000 | 10.50 | 31,500 |
| Pointed-face masonry.....................do.... | 2,450 | 13.00 | 31,850 | 13.00 | 31,850 |
| Cut-stone masonry........................do.... | 650 | 18.00 | 11,700 | 20.00 | 13,000 |
| Sills......................................do.... | 590 | 18.00 | 10,620 | 25.00 | 14,750 |
| Quoins....................................do.... | 80 | 25.00 | 2,000 | 25.00 | 2,000 |
| Coping....................................do.... | 970 | 20.00 | 19,400 | 20.00 | 19,400 |
| Stone filling..............................do.... | 12,000 | 1.50 | 18,000 | 1.50 | 18,000 |
| Riprap, hand-placed......................do.... | 2,800 | 2.50 | 7,000 | 3.00 | 8,400 |
| Paving.....................................do.... | 1,500 | 5.00 | 7,500 | 5.00 | 7,500 |
| Timber in permanent construction..feet B. M.. | 800,000 | 45.00 | 36,000 | 40.00 | 32,000 |
| Permanent piles....................linear feet.. | 1,000 | 1.00 | 1,000 | .50 | 500 |
| Bolt holes in masonry....................do.... | 4,300 | .30 | 1,290 | .40 | 1,720 |
| Total.................................... | .......... | .......... | 562,110 | .......... | 590,070 |

Bids rejected and work readvertised.

*Abstract of proposals for building one dump boat for the Great Kanawha River improvement, opened at the United States Engineer Office, Charleston, W. Va., at 3 p. m., March 9, 1893.*

| No. | Name and address of bidder. | Bid. |
|---|---|---|
| 1 | J. E. Thayer, Charleston, W. Va | $1,825.00 |
| 2 | L. Williams, Malden, W. Va | 1,690.00 |

Available for contract, $1,700.
Contract with L. Williams.

*Abstract of proposals for building two frame lock houses and outbuildings for the Great Kanawha River improvement, opened at Charleston, W. Va., at 3 p. m., March 15, 1893.*

| Kinds of work and materials. | Approximate quantities. | No. 1—C. E. Kyle, Charleston, W. Va. | | No. 2—John Morgan, Charleston, W. Va. | | No. 3—David Eagan, Charleston, W. Va. | |
|---|---|---|---|---|---|---|---|
| | | Bid. | Amount. | Bid. | Amount. | Bid. | Amount. |
| *Site of Lock No. 9.* | | | | | | | |
| Buildings | | | $2,680.00 | | $2,575.00 | | $2,849.00 |
| Masonry ....... cubic yards | 76 | $6.00 | 456.00 | $5.00 | 380.00 | $4.25 | 323.00 |
| Excavation ....... do | 60 | .30 | 18.00 | .30 | 18.00 | .29 | 17.40 |
| Pier stone | 25 | 1.50 | 87.50 | 1.50 | 37.50 | 3.00 | 75.00 |
| *Site of Lock No. 10.* | | | | | | | |
| Buildings | | | 2,600.00 | | 2,575.00 | | 2,849.00 |
| Masonry ....... cubic yards | 46 | 6.00 | 276.00 | 5.00 | 230.00 | 4.25 | 195.50 |
| Excavation ....... do | 70 | .30 | 21.00 | .30 | 21.00 | .29 | 20.30 |
| Pier stone | 15 | 1.50 | 22.50 | 1.50 | 22.50 | 3.00 | 45.00 |
| Total | | | 6,111.00 | | 5,859.00 | | 6,374.20 |

| Kinds of work and materials. | Approximate quantities. | No. 4—M. V. Smith, Charleston, W. Va. * | | No. 5—Jas. M. Mays, Charleston, W. Va. | |
|---|---|---|---|---|---|
| | | Bid. | Amount. | Bid. | Amount. |
| *Site of Lock No. 9.* | | | | | |
| Buildings | | | $2,440.00 | | $2,500.00 |
| Masonry ....... cubic yards | 76 | $3.50 | 266.00 | $5.00 | 380.00 |
| Excavation ....... do | 60 | .25 | 15.00 | .35 | 21.00 |
| Pier stone | 25 | | | 3.00 | 75.00 |
| *Site of Lock No. 10.* | | | | | |
| Buildings | | | 2,460.00 | | 2,397.00 |
| Masonry ....... cubic yards | 46 | 3.50 | 161.00 | 5.00 | 230.00 |
| Excavation ....... do | 70 | .25 | 17.50 | .35 | 24.50 |
| Pier stone | 15 | | | 3.00 | 45.00 |
| Total | | | | | 5,672.50 |

* Incomplete.

Contract with James M. Mays.

*Abstract of proposals for chains for Dams Nos. 7 and 8, Great Kanawha River improvement, opened at United States Engineer Office, Charleston, W. Va., at 3 p. m., April 4, 1893.*

| Kind of work. | Approximate quantities. | No 1 —West End Rolling Mill Co. and Chain Works, Lebanon, Pa. | |
|---|---|---|---|
| | | Bid. | Amount. |
| | *Pounds.* | *Cents.* | |
| ½-inch chain, with clevises | 9,040 | 7¼ | $655.40 |
| 7/16-inch chain, with clevises | 5,690 | 8 | 455.20 |
| 5/16-inch chain, with clevises | 4,270 | 10½ | 448.35 |
| Total | 19,000 | | 1,558.95 |

Contract with West End Rolling Mill Company and Chain Works.

*Abstract of proposals for building Lock and Dam No. 10, Great Kanawha River improvement, opened at Charleston-Kanawha, W. Va., at 3:05 p. m., April 25, 1893.*

| Kind of work. | Approximate quantities. | No. 1—Joseph Giannini, Allegheny City, Pa. | | No. 2—Zimmerman, Truax & Sheridan, Duluth, Minn. | |
|---|---|---|---|---|---|
| | | Bid. | Amount. | Bid. | Amount. |
| Grubbing and clearing complete | .......... | $1,000.00 | $1,000 | $500.00 | [illegible] |
| Crib logs in cofferdam ........ linear feet | 110,000 | .20 | 22,000 | .20 | [illegible] |
| Sheathing ........ feet, B. M. | 70,000 | 30.00 | 2,100 | 25.00 | [illegible] |
| Cofferdam filling ........ cubic yards | 15,500 | 1.20 | 18,600 | 1.00 | [illegible] |
| Excavation ........ do | 28,000 | 1.20 | 33,600 | .80 | [illegible] |
| Excavation rock ........ do | 2,600 | 3.50 | 9,100 | 1.50 | [illegible] |
| Embankment ........ do | 10,000 | .70 | 7,000 | .70 | [illegible] |
| Puddling ........ do | 350 | 3.00 | 1,050 | 2.00 | [illegible] |
| Concrete ........ do | 1,400 | 7.00 | 9,800 | 7.00 | [illegible] |
| Backing masonry ........ do | 4,250 | 8.50 | 36,125 | 9.00 | [illegible] |
| Rock-face masonry ........ do | 1,550 | 10.50 | 16,275 | 12.00 | [illegible] |
| Pointed-face masonry ........ do | 2,050 | 12.50 | 25,625 | 14.00 | [illegible] |
| Cut-stone masonry ........ do | 412 | 17.00 | 7,004 | 19.00 | [illegible] |
| Sills ........ do | 525 | 16.00 | 8,400 | 19.00 | [illegible] |
| Quoins ........ do | 72 | 18.00 | 1,296 | 24.00 | [illegible] |
| Coping ........ do | 870 | 16.00 | 13,920 | 19.00 | [illegible] |
| Stone filling ........ do | 3,400 | 1.75 | 5,950 | 2.00 | [illegible] |
| Riprap, hand placed ........ do | 2,600 | 2.50 | 6,500 | 3.00 | [illegible] |
| Paving ........ do | 900 | 4.50 | 4,050 | 5.00 | [illegible] |
| Timber in permanent construction. feet, B. M. | 132,000 | 50.00 | 6,600 | 45.00 | [illegible] |
| Bolt holes in masonry ........ linear feet | 6,400 | .40 | 2,560 | .35 | [illegible] |
| Total | .......... | .......... | 238,556 | .......... | 232,44[illegible] |

| Kind of work. | Approximate quantities. | No. 3—Thomas Munford, Lock No. 7, W. Va. | | No. 4—Harrold & McDonald, Pittsburg, Pa. | |
|---|---|---|---|---|---|
| | | Bid. | Amount. | Bid. | Amount. |
| Grubbing and clearing complete | .......... | $1,000.00 | $1,000 | .......... | .......... |
| Crib logs in cofferdam ........ linear feet | 110,000 | .25 | 27,500 | $0.20 | $22,000.00 |
| Sheathing ........ feet, B. M. | 70,000 | 30.00 | 2,100 | 35.00 | 2,450.00 |
| Cofferdam filling ........ cubic yards | 15,500 | .95 | 14,725 | 1.25 | 19,375.00 |
| Excavation ........ do | 28,000 | 1.00 | 28,000 | 1.00 | 28,000.00 |
| Excavation rock ........ do | 2,600 | 3.00 | 7,800 | 4.00 | 10,400.00 |
| Embankment ........ do | 10,000 | .65 | 6,500 | .70 | 7,000.00 |
| Puddling ........ do | 350 | 3.00 | 1,050 | 3.00 | 1,050.00 |
| Concrete ........ do | 1,400 | 7.00 | 9,800 | 8.00 | 11,200.00 |
| Backing masonry ........ do | 4,250 | 9.00 | 38,250 | 9.50 | 40,375.00 |
| Rock-face masonry ........ do | 1,550 | 10.00 | 15,500 | 10.00 | 15,500.00 |
| Pointed-face masonry ........ do | 2,050 | 12.00 | 24,600 | 12.50 | 25,625.00 |
| Cut-stone masonry ........ do | 412 | 20.00 | 8,240 | 17.50 | 7,210.00 |
| Sills ........ do | 525 | 20.00 | 10,500 | 17.50 | 9,187.50 |
| Quoins ........ do | 72 | 20.00 | 1,440 | 25.00 | 1,800.00 |
| Coping ........ do | 870 | 16.00 | 13,920 | 18.00 | 15,660.00 |
| Stone filling ........ do | 3,400 | 1.25 | 4,250 | 1.50 | 5,100.00 |
| Riprap, hand placed ........ do | 2,600 | 2.25 | 5,850 | 2.50 | 6,500.00 |
| Paving ........ do | 900 | 4.00 | 3,600 | 5.50 | 4,950.00 |
| Timber in permanent construction. feet, B. M. | 132,000 | 100.00 | 13,200 | 80.00 | 10,560.00 |
| Bolt holes in masonry ........ linear feet | 6,400 | .50 | 3,200 | .30 | 1,920.00 |
| Total | .......... | .......... | 241,025 | .......... | 245,882.50 |

Contract with Zimmerman, Truax & Sheridan.

*Abstract of proposals for building Lock and Dam No. 11, Great Kanawha River improvement, opened at U. S. Engineer Office Charleston-Kanawha, W. Va., at 3 p. m., April 26, 1893.*

| Kind of material and work. | Approximate quantities. | No. 1.—Petitdidier & Hoag, Denver, Colo. | | No. 2.—Thos. Munford, Lock No. 7, W. Va. | | No. 3.—Harrold & McDonald, Pittsburg, Pa. | |
|---|---|---|---|---|---|---|---|
| | | Bid. | Amount. | Bid. | Amount. | Bid. | Amount. |
| Grubbing and clearing, complete | .......... | $1,000.00 | $1,000.00 | $2,000.00 | $2,000.00 | $1,000.00 | $1,000.00 |
| Crib logs in cofferdam, linear feet | 215,000 | .23 | 49,450.00 | .30 | 64,500.00 | .22 | 47,300.00 |
| Sheathing....M feet, B. M.. | 120,000 | 30.00 | 3,600.00 | 40.00 | 4,800.00 | 35.00 | 4,200.00 |
| Cofferdam filling, cubic yards | 33,000 | .90 | 29,700.00 | .80 | 26,400.00 | 1.00 | 33,000.00 |
| Common excavation..do.... | 130,000 | .80 | 104,000.00 | .80 | 101,000.00 | 1.00 | 130,000.00 |
| Hard-pan excavation .do.... | 5,000 | 3.00 | 15,000.00 | 2.00 | 10,000.00 | 2.50 | 12,500.00 |
| Rock excavation .....do.... | 100 | 3.00 | 300.00 | 3.00 | 300.00 | 4.00 | 400.00 |
| Embankment ........do.... | 14,000 | .45 | 6,300.00 | .75 | 10,500.00 | .70 | 9,800.00 |
| Puddling ...........do.... | 1,600 | 2.50 | 4,000.00 | 3.00 | 4,800.00 | 3.50 | 5,600.00 |
| Concrete............do.... | 13,000 | 7.00 | 91,000.00 | 7.00 | 91,000.00 | 7.25 | 94,250.00 |
| Backing masonry ....do.... | 5,300 | 9.50 | 50,350.00 | 9.00 | 47,700.00 | 9.00 | 47,700.00 |
| Rock-face masonry...do.... | 3,000 | 13.50 | 40,500.00 | 10.00 | 30,000.00 | 10.00 | 30,000.00 |
| Pointed-face masonry do.... | 2,450 | 14.50 | 35,525.00 | 12.50 | 30,625.00 | 12.00 | 29,400.00 |
| Cut-stone masonry ...do.... | 650 | 23.00 | 14,950.00 | 18.00 | 11,700.00 | 18.00 | 11,700.00 |
| Sills ...............do.... | 590 | 25.00 | 14,750.00 | 20.00 | 11,900.00 | 18.00 | 10,620.00 |
| Quoins..............do.... | 80 | 27.00 | 2,160.00 | 20.00 | 1,600.00 | 22.00 | 1,760.00 |
| Coping..............do.... | 970 | 21.00 | 20,370.00 | 16.00 | 15,520.00 | 18.00 | 17,460.00 |
| Stone filling.........do.... | 12,000 | 1.50 | 18,000.00 | 1.00 | 12,000.00 | 1.40 | 16,800.00 |
| Riprap hand-placed ..do.... | 2,800 | 3.00 | 8,400.00 | 2.50 | 7,000.00 | 2.40 | 6,720.00 |
| Paving...... .......do.... | 1,500 | 5.00 | 7,500.00 | 4.00 | 6,000.00 | 5.00 | 7,500.00 |
| Timber in permanent construction.. M feet, B. M.. | 800,000 | 50.00 | 40,000.00 | 40.00 | 32,000.00 | 50.00 | 40,000.00 |
| Permanent piles, linear feet. | 1,000 | .75 | 750.00 | .50 | 500.00 | .50 | 500.00 |
| Bolt holes in masonry, linear feet | 4,300 | .40 | 1,720.00 | .50 | 2,150.00 | .30 | 1,290.00 |
| Total | .......... | .......... | 559,325.00 | .......... | 526,895.00 | .......... | 559,500.00 |

| Kind of material and work. | Approximate quantities. | No. 4.—Thomas, Norris & Sheridan, Duluth, Minn. | | No. 5.—Shipman & Stewart, Cincinnati, Ohio. | |
|---|---|---|---|---|---|
| | | Bid. | Amount. | Bid. | Amount. |
| Grubbing and clearing, complete | .......... | $1,000.00 | $1,000.00 | $5,000.00 | $5,000.00 |
| Crib logs in cofferdam ............linear feet.. | 215,000 | .25 | 53,750.00 | .30 | 64,500.00 |
| Sheathing.......................M feet, B. M.. | 120,000 | 25.00 | 3,000.00 | 30.00 | 3,600.00 |
| Cofferdam filling ...............cubic yards.. | 33,000 | 1.00 | 33,000.00 | .80 | 26,400.00 |
| Common excavation ...................do.... | 130,000 | 1.00 | 130,000.00 | 1.00 | 130,000.00 |
| Hard-pan excavation..................do.... | 5,000 | 2.00 | 10,000.00 | 3.00 | 15,000.00 |
| Rock excavation......................do.... | 100 | 1.00 | 100.00 | 5.00 | 500.00 |
| Embankment .........................do.... | 14,000 | .50 | 7,000.00 | .40 | 5,600.00 |
| Puddling ...........................do.... | 1,600 | 2.00 | 3,200.00 | 3.00 | 4,800.00 |
| Concrete............................do.... | 13,000 | 7.00 | 91,000.00 | 8.00 | 104,000.00 |
| Backing masonry.....................do.... | 5,300 | 8.00 | 42,400.00 | 8.00 | 42,400.00 |
| Rock face masonry...................do.... | 3,000 | 11.00 | 33,000.00 | 11.00 | 33,000.00 |
| Pointed-face masonry................do.... | 2,450 | 13.00 | 31,850.00 | 12.00 | 29,400.00 |
| Cut-stone masonry...................do.... | 650 | 18.00 | 11,700.00 | 19.00 | 12,350.00 |
| Sills ..............................do.... | 590 | 18.00 | 10,620.00 | 19.00 | 11,210.00 |
| Quoins..............................do.... | 80 | 25.00 | 2,000.00 | 25.00 | 2,000.00 |
| Coping..............................do.... | 970 | 20.00 | 19,400.00 | 14.00 | 13,580.00 |
| Stone filling ......................do.... | 12,000 | 1.50 | 18,000.00 | 1.75 | 21,000.00 |
| Riprap, hand-placed ................do.... | 2,800 | 2.50 | 7,000.00 | 3.00 | 8,400.00 |
| Paving..............................do.... | 1,500 | 5.00 | 7,500.00 | 8.00 | 12,000.00 |
| Timber in permanent construction ....M feet, B. M. | 800,000 | 45.00 | 36,000.00 | 40.00 | 32,000.00 |
| Permanent piles ..................linear feet.. | 1,000 | 1.00 | 1,000.00 | 1.00 | 1,000.00 |
| Bolt holes in masonry...............do.... | 4,300 | .30 | 1,290.00 | .40 | 1,720.00 |
| Total | .......... | .......... | 563,810.00 | .......... | 579,460.00 |

**Contract with Thomas Munford.**

## REPORT OF MR. ADDISON M. SCOTT, RESIDENT ENGINEER.

UNITED STATES ENGINEER OFFICE,
*Charleston-Kanawha, W. Va., July 1, 1893.*

COLONEL: I have the honor to submit the following report on the Great Kanawha River improvement for the year ending June 30, 1893, beginning with the principal works under construction.

### LOCK AND DAM NO. 7—MASONRY AND FOUNDATIONS OF.

[Movable dam 44 miles from mouth of river and 14 miles below Charleston.]

The lock was completed ready for the gates in February, 1892. During the last year work on the foundations and masonry of the dam was continued, and the contract covering this part of the work has just been completed. Work inside the second section of cofferdam, which included the last 100 feet of the navigation pass, the center pier, and 80 feet of the weir was completed September 10, 1892. The building of the third and last section of coffer, which included the remaining 236 feet of the weir, the shore abutment, and abutment crib was begun September 7. The foundations and masonry and the placing of the fixed irons inside the last section were nearly completed last fall, but the work was stopped for the season by cold weather December 23, 1892.

This spring machinery was got in position and the pumping of the coffer begun March 27. The masonry was completed and the last of the irons placed April 17 and the grading and riprapping of the bank—completing the contract, except the removal of the cofferdam and cleaning up the grounds—a few days later. Owing to interruptions by rises in the river the last of the cofferdam was not dredged out until last month.

The quantities, prices, and total of payments on this contract were as follows:

| | |
|---|---:|
| Grubbing and clearing site | $500.00 |
| Crib logs in cofferdams, 79,307 linear feet, at 20 cents | 15,861.40 |
| Sheathing in cofferdams, 52,766 feet B. M., at $30 | 1,582.98 |
| Filling in cofferdams, 10,865 cubic yards, at 60 cents | 6,519.00 |
| Excavation, common, including dredging, 15,355 cubic yards, at 90 cents | 13,819.50 |
| Excavation, hard pan, 1,819 cubic yards, at $1.80 | 3,274.20 |
| Excavation, rock, 8½ cubic yards, at $2.50 | 21.25 |
| Embankment, 1,693 cubic yards, at 60 cents | 1,015.80 |
| Puddling, 702 cubic yards, at $1.50 | 1,056.00 |
| Concrete, 3,081 cubic yards, at $7.25 | 22,337.25 |
| Rock-face masonry, 2,056½ cubic yards, at $10 | 20,565.00 |
| Pointed-face masonry, 462 cubic yards, at $13 | 6,006,00 |
| Cut-stone masonry, 103 cubic yards, at $15 | 1,545.00 |
| Sills, 300½ cubic yards, at $16 | 4,808.00 |
| Coping, 509 cubic yards, at $15 | 7,635.00 |
| Stone filling, 950 cubic yards, at $1.50 | 1,425.00 |
| Riprap, hand-placed, 833 cubic yards, at $2.50 | 2,082.50 |
| Timber in permanent construction, 104,620 feet, B. M., at $50 | 5,231.00 |
| Bolt holes drilled in masonry, 4,615 linear feet at 30 cents | 1,384.50 |
| Total | 116,669.38 |

Lock and Dam No. 7 are fully illustrated and described in the detailed drawings and description published by the Engineer Department last year. (See also Report of Chief of Engineers for 1892, Part 3, p. 2059, etc.)

### LOCK AND HAM NO. 8—MASONRY AND FOUNDATIONS OF.

[Movable dam 36 miles from mouth of river and 22 miles below Charleston.]

The lock with the exception of the gates was completed in February, 1892. Work on the foundations and masonry of the dam was continued during the year and the contract covering this part of the dam was completed in May.

The second section of cofferdam, which included the last 100 feet of the navigation pass, the center pier, and 80 feet of the weir, was so far completed that the pumps were started August 4. Earth excavation inside was begun on the 8th and rock excavation for the wicket anchorage on the 9th. The first masonry was set in this section August 15 and the placing of sill anchorage and concrete begun on the 20th. The first timber was put in on the 30th. The last of the fixed irons, completing work inside this section, were placed October 7. The pumps were started in the third and last cofferdam, inclosing the remaining 212 feet of the weir, the shore abutment, and crib, October 13. Work inside this cofferdam was completed December 30, when operations were suspended for the winter.

The remainder of the work covered by this contract, which included finishing, grading, and riprapping the bank about the abutment, and the removal of the cofferdams and rubbish, was completed in May.

The quantities, prices, and total of payments on this contract were as follows:

| | |
|---|---|
| Grubbing and clearing complete | $100.00 |
| Crib logs in cofferdam, 62,130 linear feet, at 18 cents | 11,183.40 |
| Sheathing in cofferdam, 50,480 feet B.M., at $30 | 1,514.40 |
| Filling in cofferdam, 9,430 cubic yards, at $1.75 | 16,502.50 |
| Excavation, common, including dredging, 15,110 cubic yards, at 65 cents | 9,821.50 |
| Excavation, rock, 1,245 cubic yards, at $3 | 3,735.00 |
| Embankment, 1,060 cubic yards, at 60 cents | 636.00 |
| Puddling, 554 cubic yards, at $1.50 | 831.00 |
| Concrete, 1,819 cubic yards, at $7.50 | 13,642.50 |
| Rock-face masonry, 1,293½ cubic yards, at $11 | 14,228.50 |
| Pointed-face masonry, 458½ cubic yards, at $13 | 5,960.50 |
| Cut-stone masonry, 97½ cubic yards, at $17.50 | 1,706.25 |
| Sills, 287½ cubic yards, at $17.50 | 5,031.25 |
| Coping, 483 cubic yards, at $17.50 | 8,452.50 |
| Stone filling, 710 cubic yards, at $1.75 | 1,242.50 |
| Riprap, hand-placed, 413 cubic yards, at $2.50 | 1,032.50 |
| Timber in permanent construction, 92,264 feet B.M., at $50 | 4,613.20 |
| Bolt holes drilled in masonry, 4,309 linear feet, at 30 cents | 1,292.70 |
| Total | 101,526.20 |

### IRONS, GATES, WICKETS, ETC., FOR NOS. 7 AND 8.

*Movable irons for dams.*—The contractors for the movable irons for Dams 7 and 8 and the extra bridge trestles for the completed dams, the Fred. J. Meyers Manufacturing Company of Covington, Ky., have made slow progress during the year, and the work is not yet completed. Owing to labor troubles last fall at the Homestead and other rolling mills, the contractors were a good deal delayed in getting the formed irons—channels, beams, etc.—and on March 4 their shops were entirely destroyed by fire, in which a considerable part of our work—principally bridge trestles, aprons, and rails, wicket horses, props, etc., in different stages of construction, were either wholly destroyed or bent and damaged so as to require a great deal of additional work. The irons for the navigation passes are nearly all finished and a greater part of them delivered; the pass and weir wicket irons and the maneuvering winches are completed and at the sites. The remaining work is principally on the bridge irons for the weir, and the weir horses, towards which a good deal has been done. The contract time has just been extended to September 1, and it is thought the work will be completed within that time.

*Irons for lock gates.*—The contract for the gate irons for Locks 7 and 8, including the valves, valve frames, journals and journal fastenings, straps, bolts, etc., was let to the lowest bidders, H. T. Morrison & Co., of Petersburg, Va., by agreement approved December 1. The work has not been energetically prosecuted and still lacks a little of being completed. The contractors made an assignment in May and the work has since been carried on by trustee. The irons are now nearly all finished and delivered at the sites. It is thought the contract will be completed during the present month.

*Building lock gates and wickets.*—The timber for the lock gates and for the wickets of the dams at Nos. 7 and 8 was purchased in open market and the building has been in progress at the sites with a hired force of carpenters and laborers nearly all the time since in November. The main beams and the heel, miter and middle blocks of gates at both locks are framed, bolted, and keyed, and the assembling and ironing has begun. The wickets for the dams, both for passes and weirs, are finished, except the panel plank, and are ironed off. The lock gates will be launched and hung as soon as finished. The placing of the wickets and of the trestles of the service bridges will be commenced this month if the stage of the river permits. The wicket horses and the bridge trestles will be attached to the boxes, which are all in place on the foundations, by divers.

*Chains for wickets and trestles.*—You contracted with the West End Rolling Mill Company and Chain Works of Lebanon, Pa., for the special chains and clevices required for the wickets and trestles of Dams Nos. 7 and 8 by agreement approved

May 17. The contractors have been working several forges on the chain. They are not likely, however, to have the work all delivered by July 15, the contract time, and will probably want a short extension.

### LOCKS AND DAMS NOS. 9, 10, AND 11.

Congress having made provision for the completion of the Great Kanawha improvement by act approved July 13, 1892, the remaining three locks and dams of the system, carrying the improvement to the mouth of the river (see Report of Chief of Engineers for 1892, pp. 2044, 2057) have been put under contract during the year. These contracts have been executed and approved within the last few weeks, and work on all three locks and dams is about to begin. A brief report of each is given below.

*Lock and Dam No. 9* (movable dam, 25 miles from mouth of river and 33 miles below Charleston).—This lock and dam was definitely located and the land at the site procured in 1890–'91.

The plans and specifications for the foundations and masonry of the lock and dam were completed in September. Proposals for the work (along with those for Nos. 10 and 11) were called for by your advertisement dated December 30, 1892. The proposals for No. 9 were opened February 16. The lowest bidder was Zimmerman, Truax & Sheridan, a Duluth, Minn., firm, to whom the contract was finally let by agreement approved May 31. One of the firm has been in the Valley since June 14 looking after quarries, etc., and arranging for materials and plant to begin the work.

Lock No. 9 will have the same chamber dimensions in plan as the other locks below Charleston—viz, 342 feet long between quoins (411 feet from out to out of masonry) and 55 feet wide in clear. The walls will be uniformly 19 feet high above top of miter sills, and from about 25 to 28 feet above bed rock.

The dam, like the other movable dams of the system, is to be a Chanoine wicket dam—operated by a trestle service bridge, consisting mainly of a navigation pass, a center pier, a weir, and a shore abutment. (See Report for 1892, p. 2057, etc.)

The works will be built entirely on solid rock found at the site from 9 to 12 feet below low-water mark. Borings indicate that in places clay pockets or soft-surfaced rock will necessitate foundations several feet below the general depth.

*Lock and Dam No. 10* (movable dam, 19 miles from mouth of river and 38 miles below Charleston).—The survey and borings for rock for the definite location of Lock and Dam No. 10 were made in May and June, 1892. Negotiations for the procurement of land needed at the site were commenced in July. The plans and specifications for the lock and dam were completed in November and proposals for the foundations and masonry, along with those for Nos. 9 and 11, were called for by advertisement of December 30, 1892. The bids for No. 10 were opened February 23, but the lowest bidder proving irresponsible the work was readvertised.

At the second opening the firm of Zimmerman, Truax & Sheridan was the lowest, with whom you contracted, by agreement approved by the Chief of Engineers June 10. This is the same firm that has the contract for Lock and Dam 9. One of the firm, as stated above, has been here since June 14 and is making arrangements to begin both works at once.

The bed rock at the site selected for No. 10 is found all the way across the river from 3¼ to 5½ feet below low-water mark. This is considerably higher than at any of the other works and reduces materially the quantities in and cost of foundations. The walls of the lock will be uniformly 19 feet above miter sills and about 20½ feet above bottom. Some rock will have to be excavated under walls and sills of both lock and dam to get the foundation courses under neat work.

*Lock and Dam No. 11* (movable dam 1¾ miles from mouth of river).—Surveys and borings for the definite location of Lock and Dam No. 11 were completed in October. Proceedings for the procurement of land at the site were commenced soon after. Plans and specifications for the lock and dam were finished in December and proposals for the foundations and masonry called for (with those for Locks and Dams 9 and 10) by advertisement of December 30. The bids for No. 11 were opened March 2, but the lowest bidder proved irresponsible and the work was readvertised, along with Lock and Dam No. 10, by notice dated March 8. At this opening (April 26 for No. 11) Thomas Munford, of Niagara Falls, Canada, was the lowest bidder for No. 11 and with him you made contract, which was approved by the Chief of Engineers June 10. This contractor is now engaged getting plant together and arranging for materials to begin work. He is one of the members of the firm that just completed the contract for Dam No. 7.

*Location, foundations, etc.*—No. 11 is located at the foot of "Three Mile Bar," or at the upper end of a minimum 6-foot channel that connects with the deep water extending to the mouth of the river. This will enable loaded coal barges to be locked down into the natural harbor above the mouth when the Kanawha and Ohio are both low. The importance of this, together with the topography and structures in the vicinity, confined the location to narrow limits and compelled the adoption of one with some unfavorable conditions. The lock will be at the lower end of a bend (there will be no material trouble, however, about the approaches) and where the bank is low with reference to high water; it is about 42 feet above low water and 19 feet below the extreme flood of 1884 in the Ohio. The land purchased on the lock side embraces some higher ground near by at the foot of the bluff, on which the lock house, shops, etc., will be located.

The depth to foundations is the most serious condition at this site. The works must be built on hard pan from 18 to 20 feet below low water. In the preliminary drillings in this part of the river this hardpan was mistaken for rock. The examinations, borings, test pits, etc., last fall showed its character and the fact that the bed rock was about 20 feet deeper, or 40 feet below low-water mark. The hardpan is a dry, compact, indurated clay about like that found at No. 7, and entirely sufficient, it is thought, for foundations. The piers of the high railroad bridge over the Ohio just above the mouth of the Kanawha rest on hardpan, and those of the bridge over Kanawha, about a mile below the lock site, without much doubt do also, though the engineers of the latter were of the opinion the caissons were down to rock. The foundations of both of these bridges are at about the same depth as the top of hardpan at No. 11—*i. e.*, 18 feet below low-water reference.

The depth to and character of the bottom called for material changes in plans for foundations, particularly in the dam, both on the score of stability and economy, over those at the other works. The navigation pass and weir is mainly crib work, filled with loose stone, with a core of concrete running through under the cushion or main sills. Masonry in the pass and weir foundations is limited to the top surfaces—coping, sills, and paving—which are mainly like those in No. 7, and the other dams recently built or planned on the river. In the lock concrete will form a considerable part of the foundation walls up to the neat line or level of miter sills, being used in the interior and for back faces of the walls and for a heavy layer under the walls throughout next to hardpan.

*General dimensions.*—The river widens considerably in the neighborhood of the mouth, and the dam at No. 11 will be from 112 feet to 218 feet longer than the other dams on the river. The navigation pass is planned 304 feet and the weir 372 feet wide. The additional width is given the pass to accommodate the towing channel, the line of which is governed mainly by the bend above and partly by some breakwater cribs for coal harbors below the site. The sills of the pass and weir will be about 17½ and 21¼ feet, respectively, above bottom of foundations. Average height from bottom of foundations, or top of hardpan, to top of wickets, about 30¼ feet. Height of center pier and shore abutment from foundations to coping, 33 feet.

The lock will have the same chamber capacity in plan as the other locks below Charleston, viz, 342 feet long between quoins, 411 feet from out to out of masonry and 55 feet wide in clear. The lift, with the water below the lock at extreme low mark, will be 11 feet. The walls will have a uniform height of 22 feet above top of miter sills and an average height of about 35¼ feet above foundations.

## OPERATING THE COMPLETED WORKS.

The five completed locks and dams were in good working order during the year. As usual a good deal was done at each, mainly by the regular lock hands, in keeping the works in order and repair, but no extended repairs were necessary.

*Ice and low water.*—The winter was unprecedentedly cold and there was an unusual amount of ice; it covered the river generally from 6 to 9 inches thick, and navigation was suspended by it from December 25 to January 30. When the ice moved it gorged considerably at the movable dams, but with the exception of damaging three wickets at No. 4 the Government works suffered no material injury.

The river in the unimproved part was very low last season and navigation was suspended below Lock 6, except for small local packets, the greater part of the summer and fall. With the exception of a light rise in November, no coal could be moved below No. 6 from July 1 to near the middle of December. This, together with the unusual suspension by ice, cut down river commerce for the year, particularly the shipment of coal, very materially.

*Account of operations.*—A brief account of operations at each of the finished locks and dams here follows:

### FIXED DAMS.

*Lock and dam No. 2.*—Locking was suspended at No. 2 during the year thirty-six days by ice and three days by high water. In addition to ordinary repairs 565 cubic yards of stone were got out in the quarry and used to repair riprap and protect the banking above the dam. The commerce through the lock was as follows:

| | | |
|---|---|---|
| Coal | bushels.. | 1,408,000 |
| Coke | tons.. | 8,455 |
| Miscellaneous freight, merchandise, produce, etc., by steamboats | do... | 5,025 |
| Lumber and logs | feet B. M.. | 108,100 |
| Coal and coak barges | number.. | 296 |
| Steamboats | do.... | 1,452 |
| Other craft | do.... | 53 |
| Shingles | do.... | 80,000 |
| Brick | do.... | 18,600 |
| Passengers | do.... | 8,791 |
| Lockages made | do.... | 1,504 |

*Lock and dam No. 3.*—Locking was suspended at No. 3 during the year thirty-six days by ice and four days by high water. The commerce through the lock was as follows:

| | | |
|---|---|---|
| Coal | bushels.. | 2,353,000 |
| Coke | tons.. | 8,900 |
| Miscellaneous freight, merchandise, produce, etc., by steamboats | do... | 6,361 |
| Lumber and logs | feet B. M.. | 1,826,850 |
| Coal and coke barges | number.. | 491 |
| Steamboats | do.... | 1,655 |
| Other craft | do.... | 48 |
| Shingles | do.... | 204,200 |
| Brick | do.... | 203,700 |
| Passengers | do.... | 11,872 |
| Lockages made | do.... | 1,733 |

## THE MOVABLE DAMS.

*Lock and dam No. 4.*—The dam was kept up 194 days during the year, and down, on account of sufficient or high stages of water, the rest of the time. The maneuvers of the dam and some of the principal items of commerce at No. 4 are given in the following tables:

| Maneuvers of dam. | Date. | Time taken. | | Men employed. | Remarks. |
|---|---|---|---|---|---|
| | | *h.* | *m.* | | |
| Lowered... | Dec. 14 | 2 | 30 | 5 | No difficulty. The dam had been up continuously since June 17. |
| Raised..... | Apr. 1 and 2 | 19 | 0 | 5 | Took out lock tripping-bar to repair it. Some delay too by wicket-chains fouling. |
| Lowered... | Apr. 5 | 4 | 0 | 6 | Delayed some by drift on weir. |
| Raised..... | Apr. 12 | 9 | 30 | 5 | No material difficulty. |
| Lowered... | Apr. 26 | 5 | 0 | 6 | Delayed 1½ hours by grab-line breaking and drifting on weir. |
| Raised..... | June 14 | 9 | 30 | 5 | No difficulty. |
| Lowered... | June 15 | 3 | 0 | 6 | Do. |
| Raised..... | June 21 | 6 | 0 | 6 | Do. |

| | | Through the lock. | Through the navigation pass. | Total. |
|---|---|---|---|---|
| Coal | bushels.. | 1,931,000 | 6,145,500 | 8,076,500 |
| Coke | tons.. | 2,055 | 6,230 | 8,285 |
| Lumber and logs | feet B. M.. | 284,000 | 658,000 | 942,000 |
| Coal barges | number.. | 526 | 1,095 | 1,621 |
| Steamboats | do... | 1,034 | 1,037 | 2,071 |
| Other craft | do... | 39 | 32 | 71 |
| Lockages | do... | ............ | ............ | 1,150 |

*Lock and dam No. 5.*—The dam was kept up 199 days during the year. The maneuvers of the dam and the most important items of commerce at No. 5 are given in the following tables:

| Maneuvers of dam. | Date. | Time taken. | | Men employed. | Remarks. |
|---|---|---|---|---|---|
| | | *h.* | *m.* | | |
| Lowered... | Dec. 14......... | 2 | 35 | 7 | No difficulty. The dam had been up continuously since June 15. |
| Raised..... | Mar. 25 and 26.. | 4 | 0 | 6 | First raising this spring. Some deposit on foundations. No material difficulty. |
| Lowered... | Apr. 5 .......... | 4 | 0 | 4 | Six pass wickets failed to trip and were lowered by hand. No material difficulty. |
| Raised..... | Apr. 13 and 14 .. | 12 | 0 | 6 | Some delay in putting tripping bar on track. |
| Lowered... | Apr. 26 ......... | 2 | 0 | 7 | No difficulty. |
| Raised..... | June 13 and 14.. | 18 | 30 | 5 and 6 | About seven hours taken to get tripping bar on track. |
| Lowered... | June 15......... | 3 | 0 | 4 | No difficulty. |
| Raised..... | June 20......... | 11 | 0 | 5 | No material difficulty. |

| | Through the lock. | Through the navigation pass. | Total. |
|---|---|---|---|
| Coal ....................bushels.. | 3,801,000 | 10,131,000 | 13,932,000 |
| Coke....................tons.. | 2,670 | 5,340 | 8,010 |
| Lumber and logs ....................feet B. M.. | 1,939,650 | 1,285,050 | 3,224,700 |
| Shingles....................number.. | 1,114,060 | (*) | ........... |
| Brick....................number.. | 68,200 | (*) | ........... |
| Salt ....................barrels.. | 686 | (*) | ........... |
| Miscellaneous freight, merchandise, produce, etc..........tons.. | 11,901 | (*) | ........... |
| Passengers....................number.. | 24,612 | (*) | ........... |
| Coal barges....................do...... | 919 | 1,649 | 2,568 |
| Steamboats ....................do...... | 1,346 | 1,140 | 2,486 |
| Other craft ....................do...... | 44 | 22 | 66 |
| Lockages made ....................do...... | 1,485 | ........... | 1,485 |

* No record.

*Lock and dam No. 6.*—The dam was kept up 186 days during the year and down the remainder of the time, owing to high or sufficient stages of water. The maneuvers of the dam and the commerce through and past this lock are given in the following tables:

| Maneuvers of dam. | Date. | Time taken. | | Men employed. | Remarks. |
|---|---|---|---|---|---|
| | | *h.* | *m.* | | |
| Lowered... | Dec. 14.......... | 2 | 15 | 5 | No difficulty. |
| Raised..... | Mar. 28 .......... | 8 | 40 | 4 | Do. |
| Lowered .. | Apr. 5 .......... | 1 | 15 | 5 | Do. |
| Raised..... | June 13 and 14.. | 12 | 25 | 4 | Delayed by trestle chains being fouled. |
| Lowered... | June 15......... | 1 | 25 | 5 | No difficulty. |
| Raised..... | June 20......... | 7 | 05 | 4 | Do. |

| | Through the lock. | Through the pass. | Total. |
|---|---|---|---|
| Coal ....................bushels.. | 962,000 | 17,926,000 | 18,888,000 |
| Coke....................tons.. | ........... | 8,900 | 8,900 |
| Coal barges ....................number.. | 632 | 2,178 | 2,810 |
| Steamboats ....................do.... | 626 | 1,337 | 1,963 |
| Other craft ....................do.... | 68 | 31 | 99 |
| Miscellaneous freight, merchandise, produce, etc..........tons.. | 7.132 | 19,673 | 26,805 |
| Passengers....................number.. | 3,736 | 15,455 | 19,191 |
| Lumber and logs .................... feet B. M.. | 2,805,000 | 7,886,450 | 10,691,450 |
| Railroad ties ....................number.. | 2,160 | 15,700 | 17,860 |
| Staves ....................do.... | ........... | 1,315,000 | 1,315,000 |
| Brick ....................do.... | ........... | 10,000 | 10,000 |
| Salt....................barrels.. | ........... | 1,700 | 1,700 |
| Lockages made....................number.. | ........... | ........... | 925 |

## MISCELLANEOUS WORK.

*Dredging.*—The Government dredge, assisted by the towboat *Bee*, was employed during the working season, when the stage of the river would permit, dredging in pools, deepening and widening the towing channels, and removing deposit from the lock approaches as follows:

From July 1 to September 16 operations were confined to the No. 4 pool; the main part of the work here was between tho foot af Lock 3 and the vicinity of the Crown Hill Coal Works. About fifteen days of the time were spent in dredging at and just above the head of Moles Island. From September 16 to November 5 the work was in the No. 5 pool at and near the head of Witchers Creek Shoal. From November 6 to 19 removing deposit from the lower approach at Lock 5. From November 22 to 29 making some trial excavations at the site of Lock and Dam No. 11. The dredge was laid up and work suspended for the season November 29.

This spring some repairs were necessary on the dredge, dump, and fuel boats. These were completed and work resumed at the lower approach at No. 5, April 17. From this date to May 17 working in the approaches of Locks 4 and 5. On May 18 the dredge was towed down to Lock 8, where it has since been steadily employed when not stopped by high water, dredging a towing channel from the lower approach of the lock to the natural deep water below. This work is still in progess.

*New Dump Boat.*—Another boat being needed with the dredge, you contracted with Mr. Layten Williams to build one by agreement April 27. Mr. Williams is now building this boat at the mouth of Elk.

*Removing Snags, etc.*—The Government crane boat, with a hired force under Capt. A. Stalnaker, towboat pilot, was employed from September 6th to 25th removing obstructions from the channel between Charleston and the mouth of the river. One hundred and twenty-one snags, sunken logs, and trees, and about 300 rocks, the latter aggregating about 125 cubic yards, were moved. Many of the sunken trees were large, and had to be cut up to be handled. The river was very low and clear at the time and favorable for the work.

*Houses at Locks 9 and 10.*—A contract for building two frame houses, including an office and out-buildings, one complete at No. 9 and one at 10, was made with J. M. Mays by agreement, approved April 10. The building at No. 9 is now nearly completed, and the one at 10 is well under way. They are like those built at Locks 7 and 8, and will be used by the engineers and inspectors during construction, and permanently by the lock keeper for a house and office.

*Steam Launch.*—With the approval of the Department, an agreement was made last November with Mr. Charles Ward to build a light-draft steam launch for the improvement. It has been built at Mr. Ward's shops here and is now nearly completed. It is a steel hull (No. 14 wire gauge), 60 feet long, 8 feet beam, depth 3 feet, draft 14 inches. It is a propeller, the screw being 24 inches in diameter, driven by a compound engine 6¼ and 13 inches diameter and 8-inch stroke. The speed of the boat is to be 10 miles per hour, and by the agreement $100 is to be deducted from the price for every quarter of a mile under this, and a like amount ($100) is to be paid as a premium for each quarter of a mile above 10 miles per hour. The boat may be rejected if the speed is less than 9 miles per hour. It will be ready for trial within the next few days.

*Columbian Exhibit.*—A full-sized model of part of Dam No. 7 was made here last winter for the World's Columbian Exposition. It consisted of two navigation pass wickets and two service-bridge trestles in place with irons and timber work of foundations of same complete. The masonry of the foundations was shown in part only, represented by wood, painted and sanded. The model was shipped and set up on the Exposition grounds at Chicago in March, just outside of the Government building. During the year a number of photographs and negatives of the locks and dams, showing the works both finished and in construction, were also made and sent to Capt. Marshall, Corps of Engineers, in charge of the engineering section of the Department exhibit, to further represent this improvement.

*Surveys, Office work, etc.*—In addition to the field and office work in connection with the works under construction, and with the location of and sites for the locks and dams referred to, the most important items of engineering and drafting during the year were as follows: Principal drawings, specifications and estimates for the foundations and masonry of Locks and Dams 10 and 11, and the completion of same for Lock and Dam No. 9. Drawings and specifications for iron work for gates at Locks 7 and 8, and for the lockhouse at 9 and 10. The completion of the detailed drawings for publication of Lock and Dam No. 2 in twelve 25 by 30 sheets with description and profile of river. These drawings are now being published by the Chief of Engineers.

The organization has remained about as it was last year, and I take pleasure in referring again to the faithful and valuable services of the men employed in the field and office, on construction and also at the finished works. Mr. T. Schoonmaker continued to act as assistant engineer and inspector on construction of Lock and Dam No. 8, and Mr. Thomas E. Jeffries in the same capacity at Lock and Dam No. 7. Both of these gentlemen were engaged part of the time on surveys and borings for the locations of the lower locks and dams, and were employed during the winter and early spring on drawings, estimates, etc., in this office. Mr. Albert M. Campbell, assistant engineer, was mainly employed until March on the detailed drawings for publication of Lock and Dam No. 2, and has since been on general field and office work, principally in connection with Locks and Dams 9 and 10. Mr. R. M. Stephens continued to act as assistant inspector at Dam No. 8. Mr. J. R. Myers was employed in the same capacity at No. 7 until October, and after that in the contractor's shops at Covington, Ky., and Petersburg, Va., on inspection of iron work.

Very respectfully, your obedient servant,

ADDISON M. SCOTT,
*Resident Engineer.*

Col. WM. P. CRAIGHILL,
*Corps of Engineers, U. S. A.*

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## COMMERCIAL STATISTICS.

UNITED STATES ENGINEER OFFICE,
*Charleston-Kanawha, W. Va., July 31, 1893.*

*Statement of the number of tons of coal, including that manufactured into coke, shipped by river from mines on the Great Kanawha, for the several years named.*

| Years. | Tons. | Years. | Tons. | Years. | Tons. |
|---|---|---|---|---|---|
| 1875 | 161, 932 | 1884 | 736, 843 | 1889 | 1, 076, 872 |
| 1876 | 200, 962 | 1885 | 712, 493 | 1890 | 966, 462 |
| 1877 | 207, 346 | 1886 | 714, 405 | 1891 | 1, 030, 454 |
| 1881 | 385, 148 | 1887 | 929, 335 | 1892 | 1, 071, 511 |
| 1883 | 614, 818 | 1888 | 804, 025 | 1893 | 919, 320 |

*Tonnage of the Great Kanawha River for year ending June 30, 1893.*

| Articles. | Quantity. | Tonnage. | Articles. | Quantity. | Tonnage. |
|---|---|---|---|---|---|
| Coal ............bushels.. | 22, 983, 000 | 919, 320 | Shingles .................. | 2, 850, 000 | 430 |
| Timber ........feet, B. M.. | 29, 080, 000 | 48, 500 | Brick ...................... | 250, 000 | 625 |
| Oak staves ................ | 1, 717, 800 | 5, 600 | Merchandise and produce by steamboats. | .............. | 53, 800 |
| Tan bark .........cords.. | 682 | 682 | | | |
| Hoop poles ................ | 832, 000 | 2, 080 | | | |
| Railroad ties, oak ........ | 570, 000 | 85, 500 | Total............... | .............. | 1, 116, 537 |

Total tonnage for—

| | |
|---|---|
| 1890 (Report of Chief of Engineers, p. 2246) | 1, 127, 232 |
| 1891 (Report of Chief of Engineers, p. 2425) | 1, 225, 355 |
| 1892 (Report of Chief of Engineers, p. 2062) | 1, 360, 750 |

The falling off in river commerce during the year was mainly due, as noted in the annual report on the Great Kanawha, to the long interruption of navigation in the unimproved part of the river by low water and the unusual suspension by ice. With the exception of a few light barges run out in November, no coal could be shipped below the locks from July 1 to December 14, and during the greater part of this time the unslack-watered river was too low for the regular passenger packets.

The river was obstructed by ice 36 days. (During the last twenty years navigation on the Great Kanawha has been suspended wholly or in part by ice 182 days, an average of about 9 days per year.)

Owing to low water and ice together there were but 101 days during the last fiscal year when full loaded (6-foot draft) coal barges could be shipped below the locks.

Respectfully submitted.

ADDISON M. SCOTT,
*Assistant Engineer.*

Col. WILLIAM P. CRAIGHILL,
*Corps of Engineers, U. S. A.*

## H H 2.

## OPERATING AND CARE OF LOCKS AND DAMS ON GREAT KANAWHA RIVER, WEST VIRGINIA.

During the fiscal year the expense of operating the locks and dams on the Great Kanawha River, in West Virginia, has been paid in the manner indicated by section 4, act of July 5, 1884.

In compliance with the proviso to that section, which requires the rendition of an itemized statement of such expenses, the following is submitted:

*Statement of expenses during the fiscal year ending June 30, 1893, out of the general appropriation for "operating and care of canals and other works of navigation," in operating and keeping in repair the locks and dams on the great Kanawha River, West Virginia.*

| | | |
|---|---|---|
| Lock and Dam No. 2: | | |
| For wages of regular lock hands | $2, 235.67 | |
| For repairs and extra labor | 244.63 | |
| For supplies, as paints, oils, fuel, tools, etc | 48.93 | |
| | | $2, 529.23 |
| Lock and Dam No. 3: | | |
| For wages of regular lock hands | 2, 248.17 | |
| For repairs and extra labor | 45.09 | |
| For supplies, as paints, oils, fuel, etc | 56.10 | |
| | | 2, 349.36 |
| Lock and Dam No. 4: | | |
| For wages of regular lock hands | 2, 395.00 | |
| For repairs and extra labor | 446.32 | |
| For supplies, as paints, oils, fuel, tools, etc | 172.77 | |
| | | 3, 014.09 |
| Lock and Dam No. 5: | | |
| For wages of regular lock hands | 2, 312.42 | |
| For repairs and extra labor | 227.46 | |
| For supplies, as paints, oils, fuel, tools, etc | 136.62 | |
| | | 2, 676.50 |
| Lock and Dam No. 6: | | |
| For wages of regular lock hands | 2, 198.00 | |
| For repairs and extra labor | 166.24 | |
| For supplies, as paints, oils, fuel, tools, etc | 98.34 | |
| | | 2, 462.58 |
| Superintendence and central office expenses: | | |
| Wages | 3, 384.16 | |
| Rent and supplies | 272.09 | |
| | | 3, 656.25 |
| Dredging at locks and part of running expenses of steamboat: | | |
| Wages | 1, 908.24 | |
| Repairs and supplies | 518.65 | |
| | | 2, 426.89 |
| Telephone line: | | |
| Rent of instruments | 140.00 | |
| Repairs and supplies | 146.91 | |
| Freight and transportation | 17.85 | |
| | | 304.76 |
| Gauge reports: | | |
| Pay of gauge observers at Hinton and Kanawha Falls | | 145.25 |
| Total | | 19, 564.91 |

## H H 3.

## IMPROVEMENT OF ELK RIVER, WEST VIRGINIA.

The work of the year was done between August 10 and October 27, 1892, with a force of hired laborers, extending over the portion of the river between Sutton and the mouth. It consisted mainly in clearing and widening the chutes, building and repairing chute walls, and opening a passage way through four abandoned dams. Many snags, overhanging trees, and other obstructions were removed.

The operations of the year have been very advantageous to the navigation of the river. An important thing remaining is the removal in part of several old dams that are still in use in a small way for power for grist or saw mills. They are a real obstruction to navigation and should be removed. They were all reported to the district attorney more than a year ago, as the law requires, but no action seems to have been taken concerning their removal.

The following are the amounts and dates of appropriations for improving Elk River, West Virginia:

| | | | |
|---|---|---|---|
| June 18, 1878 | $5,000 | August 11, 1888 | $3,000 |
| June 14, 1880 | 5,000 | September 19, 1890 | 2,500 |
| March 3, 1881 | 5,000 | July 13, 1892 | 2,500 |
| August 2, 1882 | 2,000 | | |
| August 5, 1886 | 1,500 | Total | 26,500 |

### *Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $158.89 |
| Amount appropriated by act approved July 13, 1892 | 2,500.00 |
| | 2,658.89 |
| June 30, 1893, amount expended during fiscal year | 2,574.19 |
| July 1, 1893, balance unexpended | 84.70 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895<br>Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893. | 3,000.00 |

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### REPORT OF MR. ADDISON M. SCOTT, RESIDENT ENGINEER.

UNITED STATES ENGINEER OFFICE,
*Charleston-Kanawha, W. Va., April 22, 1893.*

COLONEL: I have the honor to submit the following report of operations on the improvement of Elk River, West Virginia, since July 1, 1892:

The work done was between Little Otter, 6 miles below Sutton (Braxton Court-House) and Mink Shoals, 4 miles from the mouth of the river, embracing a distance of about 90 miles. It consisted mainly in clearing and widening the chutes and building, altering, and repairing chute walls on the shoals. A passage for rafts was also made through four old and abandoned mill dams; a break in the Blue Creek dam was repaired, and where required, snags, leaning trees, and like obstructions were removed. The work was done between August 10 and October 27, 1892, with a force of hired laborers under the overseer employed on this part of the river last year, Mr. Leslie Frame, a pilot and lumberman of Braxton County.

The following is a summary of the work done at each locality:

*Little Otter* (6 miles below Sutton and 94 from the mouth of the river).—Moved a few large stone, aggregating about 30 cubic yards, and two fallen trees from the chute and channel.

*Skidmore Dam and Shoal* (11 miles below Sutton).—Made a passage 120 feet wide for rafts and push-boats through the old abandoned mill dam. Built a side wall of loose stone on the shoal 450 feet long, about 9 feet wide at base, 3 feet on top, and 4 feet high, with stone taken from the old dam and picked up on the shoal. About 420 cubic yards of stone were placed in the wall. About 2,340 linear feet of round timber were taken from the old dam.

*Lower Rock Camp* (13 miles below Sutton).—Grubbed and trimmed brush and small trees from the bar and tow head at the head of the shoal.

*Mouth of Birch River* (22 miles below Sutton).—Made a passage 100 feet wide through the old mill dike, moving about 150 cubic yards of stone. Also cut a few leaning trees.

*Strange Creek Shoal* (24 miles below Sutton).—Blasted and moved some large stone and strengthened and built up the chute wall. Handled in all about 180 cubic yards of stone.

*Fish Pot Shoal* (25 miles below Sutton).—Blasted and moved some large stone from the chute and moved part of the side wall, handling about 80 cubic yards of stone.

*Tait Shoal* (26½ miles below Sutton).—Blasted and moved from the chute about 40 cubic yards of stone, and cut 11 leaning trees.

*Duck Creek Dam* (27 miles below Sutton).—Made a passage through the remnant of the old mill dam and blasted and removed some large stone from the chute; handling about 80 cubic yards of stone.

*O'Brien Shoal* (30 miles below Sutton).—Picked up stone from the shoal and built a low side wall 252 feet long; about 135 cubic yards of stone were used. Also cut and removed some sunken logs from the channel.

*Groves Shoal* (31 miles below Sutton).—Scraped—with horse-scrapers—and picked stone from shoal and made a raft channel 120 feet wide along the left shore. Stone moved and placed on shore and side wall about 290 yards. Also trimmed leaning timber on the left shore.

*End of the World* (32 miles below Sutton).—Trimmed the right hand shore, and moved about 15 cubic yards of stone from channel.

*Standing Rock Shoal* (36 miles below Sutton).—Scraped and moved by hand stone from shoal and made a sidewalk 306 feet long; wall about 10 feet wide at base, 3 feet at top, and 4 feet high; it contains about 370 cubic yards of stone.

*Red House Shoal* (39 miles below Sutton).—Cleared the chute of large stone, taking out about 43 cubic yards.

*Big Spread Shoal* (42 miles below Sutton).—Built a wall 910 feet long on right-hand side of raft channel with stone taken from the shoal; wall about 10 feet wide at base, 4 feet on top, and 3½ feet high; it contains about 700 cubic yards of stone.

*Long Run Shoal* (44 miles below Sutton).—Blasted and moved from chute 7 large stone, aggregating about 55 cubic yards.

*Wild Goose Dam* (45 miles below Sutton).—Cleared out part of remnant of old mill-dam to improve the raft channel, moving about 65 cubic yards of stone and 400 linear feet of round timber.

*Eagle Plains* (48 miles below Sutton).—Moved from chute about 90 cubic yards of stone, and cut up and moved 3 fallen trees.

*Big Buffalo Shoal* (49 miles below Sutton).—Made a chute along the left shore, moving about 190 cubic yards of stone and gravel, and cutting and moving 15 trees and stumps. Also built a low wall 120 feet long between the Two Islands, and blasted from the chute 17 stone, the latter aggregating about 40 cubic yards.

*Big Leatherwood Shoal* (53 miles from Sutton).—Took stone out of the raft channel and raised the old chute wall on the left, placing on it about 640 cubic yards and raising it about 4 feet throughout. Also widened the channel on the right by blasting 38 rock near the head of shoal, and taking out remnant of an old mill dike. Total material handled here, about 1,018 cubic yards of stone and 500 linear feet of timber, the latter being taken from the old dike, and leaning trees cut along shore.

*Lick Branch and Middle Creek.*—Blasted 8 large stone and scraped out a narrow chute for push boats.

*Big Beechy Shoal* (54 miles below Sutton).—Built 2 walls, one on right and one on left of raft channel, with stone picked up on the shoal; handled 180 cubic yards of stone.

*Blue Knob Shoal* (55 miles below Sutton).—Blasted and cleared stone from raft channel, moving about 145 cubic yards, and trimmed some leaning trees along the right shore.

*Yankee Dam* (56 miles below Sutton).—Hauled about 60 cubic yards of stone and raised and repaired the wall at the head of the island.

*Dry Knob Shoal* (60 miles below Sutton and 40 from mouth of river).—Built low wall on each side of channel. Blasted 11 large stone. Total stone used, about 270 cubic yards.

*Big Laurel* (37 miles from mouth of river).—Moved the right-hand wall back toward shore from 48 to 75 feet and raised it about 3½ feet; length of the wall, 780 feet. Built up the left-hand wall and lengthened it 100 feet, making it 690 feet long.

Also scraped down a gravel bar in raft channel, lowering it from 6 to 16 inches. Material handled at Laurel, about 750 cubic yards of stone and 150 yards of gravel.

*Twistabout Shoal* (36 miles from mouth).—Raised and strengthened the right-hand wall, adding about 130 cubic yards of stone to it.

*Ashleys Dam* (35 miles from mouth).—Blasted 3 stone and cleaned up the chute, moving about 25 cubic yards.

*King Shoal* (31 miles from mouth of river).—Picked from the chute and placed on the left-hand wall about 125 cubic yards of stone, and cut up and moved three fallen trees.

*Little Spread Shoal* (28 miles from mouth).—Built a low side wall 115 feet long with stone taken from the shoal, handling about 115 cubic yards of stone.

*Queen Shoal* (25 miles from mouth).—Raised the chute wall on the left about 2 feet higher throughout, with stone taken from the shoal; length of wall, 1,130 feet. Also widened the chute 30 feet at the head by moving back the right-hand wall, and blasted 13 large stone on the shoal. Total quantity of stone handled at Queen about 630 cubic yards.

*Morris Creek Shoal* (24 miles from mouth).—Widened and straightened the chute by moving back the side walls. Also blasted 7 large stone from raft channel, near the right shore, one of them containing about 90 yards. Total stone moved, about 215 cubic yards.

*Little Leatherwood* (20 miles from mouth).—Widened and improved the chute by taking out the remnant of an old dike on the right and repairing the left wall. Handled in all about 200 cubic yards of stone and gravel and 1,500 linear feet of old timber.

*Jordan Creek* (18½ miles from mouth).—Blasted and took out 6 stone from channel, aggregating about 35 cubic yards.

*Youngs Shoal* (16 miles from mouth).—Moved about 15 yards of stone from the chute to right-hand shore.

*Blue Creek Dam* (14 miles from mouth).—Repaired a break in this old timber and stone dam. The break was 84 feet wide and about 7½ feet deep. Also raised and strengthened the dam at other points as required. In repairing the dam 750 linear feet of long timber—being full-length trees with tops, to form a bottom for, and apron below, the break—1,776 linear feet of longitudinal sticks and ties, 300 drift bolts, and 270 cubic yards of stone were used.

*Jarretts Ford* (12 miles from mouth).—Repaired the left-hand dike at head of chute, adding about 60 cubic yards of stone to it, and cut up 11 sunken snags and trees at the foot of the shoal on the right.

*Porters Shoal* (8 miles from mouth).—Moved from chute next to left bank about 95 cubic yards of stone and cut up one large tree. Cut up 8 sunken trees and snags between Porter and Mink shoals.

*Mink Shoal* (4 miles from mouth of river).—Moved about 55 cubic yards of stone to straighten and widen the chute. Also blasted and removed 13 stones from the channel in the neighborhood of Mink, that aggregated about 10 cubic yards.

The work, as before stated, was stopped October 27, 1892, the appropriation being then nearly exhausted.

The only additional work that it seems expedient to do on the Elk, in the line of improvement heretofore pursued, is the removal of the old milldams that are still in use on the river and are so frequently alluded to in former annual reports of the Chief of Engineers. You furnished the United States district attorney, Mr. George C. Sturgiss. a list and description of these dams, the names of the owners, and list of witnesses in January, 1892, but so far as I am informed no action has yet been taken by the Department of Justice toward their removal. These old dams. used in a small way for water power to run grist or saw mills, are real obstructions to navigation, and should, in justice to the river interests, have been dispensed with and torn out years ago.

Very respectfully, your obedient servant,

ADDISON M. SCOTT,
*Resident Engineer.*

Col. WILLIAM P. CRAIGHILL,
*Corps of Engineers, U. S. A.*

## COMMERCIAL STATISTICS.

UNITED STATES ENGINEER OFFICE,
*Charleston-Kanawha, W. Va., July 25, 1893.*

*Commercial statistics for Elk River, West Virginia.*

| Year. | Saw logs and lumber. | Railroad ties (oak). | Oak staves. | Hoop poles. | Hickory spokes. | Tanbark oak. | Tonnage of timber products. |
|---|---|---|---|---|---|---|---|
|  | *Feet, B. M.* |  |  |  |  | *Cords.* | *Tons.* |
| 1883 | 5,200,000 | 100,000 | 898,334 | ........ | ........ | ........ | [illegible] |
| 1884 | 5,975,000 | 125,000 | 1,122,500 | ........ | ........ | ........ | [illegible] |
| 1885 | 5,100,000 | 250,000 | 1,433,750 | ........ | ........ | ........ | [illegible] |
| 1886 | 15,361,000 | 250,000 | 1,845,000 | ........ | ........ | ........ | [illegible] |
| 1888 | 15,900,000 | 330,000 | 1,210,000 | ........ | ........ | ........ | [illegible] |
| 1889 | 15,750,000 | 295,000 | 1,600,000 | 500,000 | 350,000 | ........ | [illegible] |
| 1890 | 26,650,000 | 330,000 | 1,380,000 | 150,000 | 568,000 | 300 | [illegible] |
| 1891 | 27,995,000 | 412,500 | 800,000 | 125,000 | 200,000 | 500 | [illegible] |
| 1892 | 44,400,000 | 380,000 | 1,405,000 | ........ | ........ | 240 | [illegible] |
| 1893 | 37,516,000 | 353,000 | 1,390,000 | ........ | ........ | 612 | [illegible] |

Of saw logs and lumber during the last year about 27,000,000 feet were poplar, 8,000,000 oak, and the remainder hemlock, ash, walnut, maple, etc.

The general merchandise and produce carried on the river is estimated at 6,000 tons, making the total for the year, with the timber products as above, 131,400 tons.

Respectfully submitted.

ADDISON M. SCOTT,
*Resident Engineer.*

Col. WM. P. CRAIGHILL,
*Corps of Engineers, U. S. A.*

## H H 4.

## IMPROVEMENT OF GAULEY RIVER, WEST VIRGINIA.

The small amount of money available for this river was expended in July, August, September, and October, 1892. The work of the year has had the effect of causing the movement of much local freight by boats which otherwise would have been hauled by teams at much greater cost. The country along the Lower Gauley is being opened up.

The water in the low-water season of 1892 was unusually low, which was favorable for rapid work but not for navigation. The winter of 1892-'93 was unusually severe, but the ice did no serious damage to the chute-walls, etc.

Two railroad bridges have been built during the year, one at the mouth of the river and the other 5 miles above. For both, the height and width of spans were prescribed by the Secretary of War.

For details of the work of the year reference is made to the attached report of Mr. W. Proctor Smith.

The following are the amounts and dates of appropriations for improving Gauley River, West Virginia:

|  |  |
|---|---|
| August 11, 1888 | $3,000 |
| September 19, 1890 | 3,000 |
| July 13, 1892 | 3,000 |
| Total | 9,000 |

### *Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $82.68 |
| Amount appropriated by act approved July 13, 1892 | 3,000.00 |
| | 3,082.68 |
| June 30, 1893, amount expended during fiscal year | 2,964.80 |
| July 1, 1893, balance unexpended | 117.88 |
| Amount (estimated) required for completion of existing project | 66,000.00 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895 | 5,000.00 |
| Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893. | |

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### REPORT OF MR. WILLIAM PROCTOR SMITH, ASSISTANT ENGINEER.

BALTIMORE, MD., *December 29, 1892.*

COLONEL: I have the honor to report the following operations on the improvement of Gauley River, W. Va., for the season of 1892.

Instructions to begin work were received on the 20th of July. On the 22d July the assistant engineer reported at Gauley Bridge, organized a force, had boats calked, tools sharpened, property moved to and camp established at Twenty Mile Creek, 5 miles above the mouth of the river, and began the work on the 26th at that point.

This work consisted in removing the curvature from the walls at the head, in widening the channel at the lower end, and in taking out the loose stone collected during the winter.

The work was commenced at this point, as a railroad was being built along the river bank, and the contractors were constantly throwing stone in the river from blasting, which would have kept the men in danger or else idle too much of their time in getting out of the way.

On the 31st of July camp was moved to Mill Shoal, 7½ miles from the mouth of Gauley River, and work was begun on a straight channel through this shoal August 1 and completed September 7.

This shoal is 1,150 feet in length and the channel through it is 30 feet wide and 2 feet deep at ordinary low water, and was made by removing loose rock, solid rock, bowlders, sand, and gravel, and building the same into walls on either side, with wing walls at the head, constructed out of the same material with the addition of brush. The length and other dimensions of walls are as follows:

North wall, 966 feet long, 5 feet wide, and 3½ feet high.
South wall, 920 feet long, 5 feet wide, and 3 feet high.
North wing wall, 188 feet long, 8 feet wide, and 3 feet high.
South wing wall, 470 feet long, 8 feet wide, and 2 feet high.

September 8 and 9, improved two shoals immediately below Mill Shoal, and on the 10th moved camp to Tritts Shoal above the mouth of Little Elk Creek, and 9¾ miles from Gauley Bridge, from which place work at all the shoals above, except one, was done.

At Tritts the straight high-water chute was deepened, the walls were strengthened, and wing walls 792 feet in length were built at the head, completely cutting off the water from the crooked channel in use heretofore.

At Upper Shoal, 10¾ miles above the mouth of the river, new walls were built 157 feet in length.

September 24, finished Little Ledges, 12½ miles above the mouth of the river. Two-thirds of this work was blasting. Two hundred and ninety-six feet of new walls were built here.

September 26, moved the force downstream, doing some work at the channels along the line. September 27, camped at Long Shoal, 3½ miles above the mouth of the stream, and next day went to work removing loose rock from the channel, of which a considerable quantity had accumulated, particularly at the foot of the chute.

Continuing downstream, 210 feet of new wall were built at Durdens Ripple, and the west main wall at Durdens Rock increased in length and a wing wall built at its head. Total length of new walls here 378 feet.

The channel at Kincaid Shoal, 2½ miles above the mouth of Gauley River, was widened to 30 feet throughout its length of 525 feet.

At Big Creek, 1¾ miles above the mouth of Gauley, the channel was widened throughout its lenghth and 300 feet of new walls were built.

At Humphreys Shoal, one-fourth mile below, some blasting was done. At Buck Ford, two-thirds of a mile above mouth of stream, the channel was widened 10 feet throughout its length of 120 feet. This work is solid rock, the material from which was built into a wall 155 feet long.

At Scrabble Creek Ledges a new channel was made near the left bank of the river, 100 feet in length, 30 feet wide, and 2 feet deep, through solid rock, which gave material for 140 feet of walls. The old crooked chute was closed up with a wing dam to throw all of the water into the new channel.

The work was closed out on the 22d of October by making a chute 35 feet in width by blasting out bowlders at the bridge pier near the mouth of the river.

On the 24th of October, 1892, the property was stored with J. H. Miller, jr., at Gauley Bridge, W. Va.

Twenty-seven shoals were improved this year, giving a good channel from the mouth of the river to the first shoal in the Roughs, a distance of 12½ miles, 30 feet wide and 2 feet deep at ordinary summer water.

The time from the finishing off the actual work in the river to November 12 was occupied in measuring up the work of the season and in making sketches of the points at which the principal work was done.

Five thousand and thirty-four feet of new walls were built, from 3 to 8 feet wide and from 1 to 6 feet high.

Two hundred and fifty-six holes were drilled to an average depth of 1¼ feet and 266 blasts were fired. Four thousand four hundred and forty-five cubic yards of loose rock and bowlders and 263 feet cubic yards of solid rock were removed at a cost of 45 cents per cubic yard for the former and $1.46 for the latter.

For details reference is made to table.

Two hundred pounds of No. BB Ætna powder, 35 per cent nitroglycerine, 1,200 feet of double-taped fuse, and 250 primers were used during the season.

Out of 79 working days only 6 were lost.

The average number of men employed per day of eight hours was a fraction less than 14. The wages per day of eight hours to September 19 was $1.20; after that, $1.50 was paid on account of colder weather. It rained more or less on 14 days.

Highest gauge reading, 1.75 feet above zero, and lowest, 2.1 feet below; this being the lowest point ever known to have been reached. The water was very low nearly all of the working period; there was really but one rise and that was only 3 feet.

It was very warm in July and August. Some days the thermometer read 98° in the shade.

By observations made October 6 in the new straight channel at Mill Shoal, 7½ miles above the mouth of the river, the fall through which is 5.5 feet as taken with a Locke level, when the river was 1.4 feet below ordinary low water, the velocity was found to be 2.72 miles per hour and the quantity 69.5 cubic feet per second.

November 10 the river raised sufficiently for boats to run and two of them began to carry down lumber. There are six of these boats in all; the largest 80 feet long, 8 feet wide, and drawing 17 inches when loaded with 15,000 feet of lumber.

Four million feet of lumber, 500,000 feet of logs, and 750,000 staves are ready to come out as soon as the boats can carry them.

One small skiff was purchased and two rock boats were built, 20 feet long, 5 feet wide, 15 inches deep, and decked over with 1¼-inch oak plank at a cost of $20.33 each. The Chesapeake and Ohio Railway has graded a branch road from the main line on the south side of New River, crossing New River by a bridge at Narrow Falls, 1 mile above the mouth of Gauley River, thence down New River to Gauley River, and up the east bank of same 5 miles to the mouth of Twenty Miles Creek.

At this point the company is building the masonry for a deck bridge 618 feet long of six spans, 103 feet each from center to center of piers, and 98 feet clear span at the top.

This bridge crosses over the low-water channel, with the bridge and channel both on curves.

By your direction the assistant engineer looked after the construction of the same to see that it was put up in conformity with the instructions from the War Department. With this authority it was seen to that the company gave a 60-foot channel between the piers, the axis of which was 30 feet perpendicular distance from the dangerous angles of the piers. These channel piers were built on a skew of forty from the tangent of the bridge, to give sufficient width of waterway.

Instructions have been given this company that all material taken from the pits dug for foundations shall either be thrown back into the pits or removed; that a sluice, made to turn the water whilst building the masonry, be filled up, and that about 8 inches of gravel at the former site of sluice dam be taken out. This was not done, owing to a rise in the stream on the 19th of November, but will be attended to as soon as the water falls.

The piers are all well above high water, but only the foundation for the west abutment is built and nothing but the pit dug at the east abutment.

The Kanawha and Ohio Railroad, from Charleston, W. Va., up the north side of the Kanawha River, is nearly finished as to grading and masonry.

This road crosses the Gauley River at its mouth, 155 feet below the piers of an old burnt bridge of the James River and Kanawha turnpike, and makes a junction with the Chesapeake & Ohio Railway, about 1,000 feet from the east bank of the stream, and there stops.

This company is building the masonry of a through bridge at this point 623 feet in length. Three spans 171 feet from center to center of piers and two spans of 55 feet from same points. The assistant also looked after the building of this bridge. One abutment and three piers are finished and the other two are well above high water.

This railroad work consumed the remainder of the month of November after the river work was completed.

In building these roads the contractors blasted considerable quantities of rock into the river and channels and also threw a quantity of timber into the same, which have all been removed and now the channels are free from obstructions.

The month of December was devoted to office work, as follows: In collecting data for, and in writing this report. In tabulating the detail work for the season. In making maps or sketches of the two railroad bridges and tracings of the same. The Chesapeake & Ohio sketch is made to a scale of 20 feet to the inch and the Kanawha & Ohio sketch to a scale of 50 feet to the inch. Each sketch shows the relation of the channels to the piers.

In putting the general location of these railroads and bridges on a map of Gauley River, in the Baltimore office, made in 1891, to a scale of 800 feet to the inch. And in showing the work done in the river this season, on the same map.

Respectfully submitted.

WM. PROCTOR SMITH,
*Assistant Engineer.*

Col. WILLIAM P. CRAIGHILL,
*Engineer Corps, U. S. A.*

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*Table showing the details of work on the improvement of Gauley River, West Virginia, during the season of 1892.*

| Name of shoal. | Distance from mouth of Gauley River. | Length of new walls. | Length of drilling. | Blasts. | Holes drilled. | Loose rock and bowlders. | Solid rock. |
|---|---|---|---|---|---|---|---|
| | *Miles.* | *Feet.* | *Feet.* | *No.* | *No.* | *Cu. yds.* | *Cu. yds.* |
| Junction of New and Gauley River. | 0 | .......... | 9 | 7 | 7 | .......... | 21 |
| Scrabble Creek | ¼ | 140 | 146 | 90 | 90 | .......... | 80 |
| Buck Ford | ¾ | 131 | 88 | 56 | 56 | .......... | 55 |
| Humphreys | 1⅛ | 6 | 8 | 6 | 6 | .......... | 8 |
| Big Creek | 1¾ | 304 | 24 | 4 | 3 | 82 | .......... |
| Pool | 2 | 143 | .......... | .......... | .......... | 41 | .......... |
| Winding | 2⅛ | .......... | .......... | 1 | .......... | 5 | .......... |
| Kincaid | 2¼ | 44 | .......... | .......... | .......... | 115 | .......... |
| Durden Rock | 2⅝ | 148 | .......... | .......... | .......... | 250 | .......... |
| Durden Ripple | 3 | 210 | .......... | .......... | .......... | 84 | .......... |
| Long | 3½ | .......... | .......... | .......... | .......... | 372 | .......... |
| Twenty Mile | 5 | 50 | .......... | .......... | .......... | 237 | .......... |
| Twenty Mile (first above) | 5¾ | .......... | .......... | .......... | .......... | 68 | .......... |
| Twenty Mile (second above) | 6¼ | 10 | .......... | .......... | .......... | 26 | .......... |
| Twenty Mile (third above) | 6½ | .......... | .......... | .......... | .......... | 25 | .......... |
| Fosters | 6¾ | 200 | .......... | .......... | .......... | 235 | .......... |
| Fosters (first above) | 7 | 75 | .......... | .......... | .......... | 10 | .......... |
| Fosters (second above) | 7 5/16 | 55 | .......... | 1 | .......... | 23 | .......... |
| Fosters (third above) | 7 7/16 | .......... | 5 | 4 | 3 | 76 | .......... |
| Mill | 7½ | 2,544 | 51 | 53 | 51 | 1,773 | 50 |
| Church Hollow | 9¼ | 25 | .......... | .......... | .......... | 108 | .......... |
| Simms | 9½ | .......... | .......... | .......... | .......... | 88 | .......... |
| Tritts | 9¾ | 553 | .......... | .......... | .......... | 250 | .......... |
| Ford | 10 | 100 | .......... | .......... | .......... | 10 | .......... |
| Laurel | 10½ | .......... | .......... | .......... | .......... | 125 | .......... |
| Upper | 10¾ | .......... | .......... | .......... | .......... | 230 | .......... |
| Little Ledges | 12½ | 296 | 36 | 44 | 40 | 212 | 49 |
| Total | .......... | 5,034 | 367 | 266 | 256 | 4,445 | 263 |

### REPORT OF MR. WILLIAM PROCTOR SMITH, ASSISTANT ENGINEER.

GAULEY BRIDGE, W. VA., *July 5, 18*[illegible]

COLONEL: I have been up Gauley River from its mouth to the first shoal in the Roughs, 12½ miles, and have to report as follows:

I found the work in good condition from the bridge to Long Shoal, 3¼ miles, at the head of which, for a distance of 180 feet and 400 feet lower down on the west wall for a distance of 75 feet the ice has flattened the wall, reducing its height about [illegible] inches, and at the middle of the wing wall there is a break of 25 feet.

At Twenty Mile Creek, 5 miles from mouth of stream, about 200 feet of the lower end of the left wall, going up stream, has had about 6 inches of stone removed.

Work all good from the above point to Mill Shoal, 8 miles from the bridge, at the foot of which a shoal has been formed the width of the channel (30 feet) 50 feet in length and 1 foot deep, caused by the washing out of the loose rock, sand, and gravel from the newly-made channel, the depth of water in the chute has been increased proportionately.

On the south wall, 250 feet from the lower end, the ice has reduced the height of the wall about 1 foot for a depth of 75 feet; this makes no difference, however, as to the water in the channel, for the wall was built merely to use up the material removed from the channel, and not to hold up the water.

At the head of the wall on the north side for a distance of 160 feet a break has been made, averaging a depth of 9 inches, still leaving, however, about 2 feet of wall to hold up the water and turn it into the chute.

The wing walls seem to be intact. Some loose stone in this channel, but not sufficient to stop boats, the shoal at the lower end, however, is an obstruction.

Notwithstanding the breaks I found plenty of water in the channel.

Work all in good shape from mill to upper shoal, 10½ miles from the mouth of Gauley; here the walls are flattened and spread somewhat, but they are still high enough.

From Upper Shoal to first Shoal in the Roughs, the end of the channel work, everything was in good condition.

River about 3 feet above zero or ordinary low water and slightly muddy.

Four bateaux and flat boats are carrying lumber down from Mill Shoal and points below.

You will notice that nearly all of the damage was done at shoals at the foot of Long Pools, where the ice could form and gorge—and too, that the work was done last summer and is therefore new and more likely to suffer. I think the damage very slight considering the heavy gorges of 13 feet of ice reported.

Respectfully,

WM. PROCTOR SMITH.

Col. WILLIAM P. CRAIGHILL,
*Engineer Corps, U. S. A.*

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*Commercial statistics for Gauley River, West Virginia.*

| Year ending June 30— | Saw logs. | Lumber. | Staves. | Shingles. | Tonnage of timber. | Produce, etc. | Total from Gauley. | Merchandise to Gauley. |
|---|---|---|---|---|---|---|---|---|
| | *Feet.* | *Feet.* | | | | *Tons.* | *Tons.* | *Tons.* |
| 1888 | 691,800 | 2,535,300 | 177,400 | .......... | 7,121 | 30 | 7,151 | [illegible] |
| 1889 | 890,400 | 3,615,000 | 274,200 | .......... | 9,491 | 78 | 9,569 | 1,[illegible] |
| 1890 | 384,800 | 4,452,500 | .......... | .......... | 9,676 | 90 | 9,766 | 1,[illegible] |
| 1891 | 384,700 | 4,701,300 | 100,000 | .......... | 10,347 | 89 | 10,436 | 1,[illegible] |
| 1892 | 261,170 | 5,249,200 | 1,200,000 | 111,000 | 9,527 | 103 | 9,630 | [illegible] |
| 1893 | 302,000 | 5,470,000 | 113,700 | 75,000 | 9,457 | 114 | 9,571 | 2,[illegible] |

## H H 5.

### IMPROVEMENT OF NEW RIVER, VIRGINIA AND WEST VIRGINIA.

There has been no work on this river in the year ending June 30, 1893.

The following are the amounts and dates of appropriations for improving New River, Virginia and West Virginia:

| | | | |
|---|---|---|---|
| August 14, 1876 | $15,000 | August 2, 1882 | $12,000 |
| June 18, 1878 | 15,000 | August 5, 1886 | 10,000 |
| March 3, 1879 | 12,000 | | |
| June 14, 1880 | 24,000 | Total | 112,000 |
| March 3, 1881 | 24,000 | | |

*Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $2,341.79 |
| July 1, 1893, balance unexpended | 2,341.79 |
| Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867. | 159,000.00 |

# APPENDIX II.

## IMPROVEMENT OF CERTAIN RIVERS IN KENTUCKY AND WEST VIRGINIA.

### *REPORT OF MAJ. D. W. LOCKWOOD, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1893, WITH OTHER DOCUMENTS RELATING TO THE WORKS.*

#### IMPROVEMENTS.

1. Tradewater River, Kentucky.
2. Lock No. 2, Green River, at Rumsey, Ky.
3. Green River above mouth of Big Barren River, Kentucky.
4. Operating and care of locks and dams on Green and Barren rivers, Kentucky.
5. Rough River, Kentucky.
6. Kentucky River, Kentucky.
7. Operating and care of locks and dams on Kentucky River, Kentucky.
8. Licking River between Farmers and West Liberty, Kentucky.
9. Big Sandy River, West Virginia and Kentucky.
10. Levisa Fork of Big Sandy River, Kentucky.
11. Tug Fork of Big Sandy River, West Virginia and Kentucky.
12. Guyandotte River, West Virginia.
13. Little Kanawha River, West Virginia.
14. Operating and care of lock and dam on Little Kanawha River, West Virginia.
15. Buckhannon River, West Virginia.

#### EXAMINATIONS.

16. Licking River, Kentucky.
17. Bar at junction of Big Sandy and Ohio rivers.

UNITED STATES ENGINEER OFFICE,
*Cincinnati, Ohio, July 10, 1893.*

GENERAL: I have the honor to transmit herewith the annual reports on work under my charge at the close of the fiscal year ending June 30, 1893.

First Lieut. Wm. L. Sibert, Corps of Engineers, was on duty under the direction of this office up to August 18, 1892.

First Lieut. Jas. J. Meyler, Corps of Engineers, has been on duty from October 19, 1892, and First Lieut. H. E. Waterman, Corps of Engineers, since May 10, 1893.

Very respectfully, your obedient servant,

D. W. LOCKWOOD,
*Major of Engineers.*

Brig. Gen. THOMAS L. CASEY,
*Chief of Engineers, U. S. A.*

## I I 1.

## IMPROVEMENT OF TRADEWATER RIVER, KENTUCKY.

The Tradewater is a tributary of the Ohio and empties into it 79 miles below Evansville, Ind.

The project for the improvement, adopted in 1881, contemplated originally the removal of obstructions, such as bars, snags, etc., so as to open up to navigation 22 miles of the river by forming a channel with a minimum width of 40 feet and a minimum depth of 2½ feet for six months in each year. The survey upon which the project was based covered 41 miles of the river, and the scope of the work has been extended to embrace this, although the depth of 2½ feet can only be secured for about five months each year in the upper portion.

The river has been thoroughly gone over from its mouth to the upper limit of the improvement, 41½ miles above, and while the improvement is not permanent, the obstructions to navigation, such as snags, sunken logs, etc., being liable to reform after each high water, no further appropriation at the present time is deemed requisite, as the unexpended balance from former appropriations will be sufficient for the ensuing fiscal year.

APPROPRIATIONS.

| | |
|---|---|
| March 3, 1881 | $3,000 |
| August 2, 1882 | 3,500 |
| July 5, 1884 | 2,000 |
| August 5, 1886 | 2,000 |
| August 11, 1888 | 6,000 |
| Total | 16,500 |

*Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $907.10 |
| June 30, 1893, amount expended during fiscal year | 145.75 |
| July 1, 1893, balance unexpended | 761.35 |

NOTE.—It has been impossible to obtain any commercial statistics.

---

## I I 2.

## RECONSTRUCTION OF LOCK NO. 2, GREEN RIVER, AT RUMSEY, KY.

### REBUILDING LOCK NO. 2.

In the deficiency act of March 3, 1893, an appropriation of $65,000 was made for rebuilding Lock No. 2, Green River. A project and estimate for the expenditure of this amount was submitted under date of March 23, 1893, and approved April 12, 1893.

As the amount appropriated is insufficient to complete the lock, it is proposed to build the upper end this season and replace the dam so as to make everything safe, and then, when sufficient money has been appropriated, to complete the whole work.

If possible, navigation will not be interrupted, as the new lock will be located on the river side of the old one. But it is doubtful if the head of the old river wall will stand when the support of the dam is withdrawn; should this turn out to be true, then navigation will have to be closed at this point until the new lock is completed. As it would be difficult to construct a cofferdam against a head of 14 feet, in addition to the natural head in the lower pool, it is proposed to construct an auxiliary dam above, or part of the old dam, so as to gain sufficient distance upstream for the head of the lock and the coffer surrounding it. In this way the latter will be entirely in the lower pool.

On account of high water but little has been done so far this year beyond making the necessary preparations for commencing work. The estimated cost of this improvement is $170,000, and with the balance of the estimate, $105,000, it can be completed in one season.

*Abstract of contracts for rebuilding Lock No. 2, Green River, Kentucky, in force during the fiscal year ending June 30, 1893.*

| Contractors. | Nature of contract. | Date. | To expire. |
|---|---|---|---|
| Eigenmann & Hollerbach | Furnishing stone | May 18, 1893 | Sept. 30, 1893 |
| J. B. Speed & Co | Furnishing cement | May 23, 1883 | Sept. 30, 1893 |

### APPROPRIATIONS.

| | |
|---|---|
| March 3, 1893 | $65,000 |

### *Money statement.*

| | | |
|---|---|---|
| Amount appropriated by act approved March 3, 1893 | | $65,000.00 |
| June 30, 1893, amount expended during fiscal year | | 1,645.39 |
| July 1, 1893, balance unexpended | | 63,354.61 |
| July 1, 1893, outstanding liabilities | $1,176.42 | |
| July 1, 1893, amount covered by uncompleted contracts | 27,086.28 | |
| | | 28,262.70 |
| July 1, 1893, balance available | | 35,091.91 |
| Amount (estimated) required for completion of existing project | | 105,000.00 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895 | | 105,000.00 |

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

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*Abstract of proposals received and opened May 8, 1893, by Maj. D. W. Lockwood, Corps of Engineers, for furnishing stone for improving Green River, Kentucky, rebuilding Lock No. 2.*

| No. | Name and address of bidder. | Special stone, 212.71 cubic yards. | Cut stone, dressed face, 400 cubic yards | Cut stone, quarry face, 440 cubic yards. | Backing stone, 1,600 cubic yards. | Total. |
|---|---|---|---|---|---|---|
| | | *Per cu.yd.* | *Per cu.yd.* | *Per cu.yd.* | *Per cu.yd.* | |
| 1 | Eigenmann & Hollerbach, Evansville, Ind. | $18.00 | $13.00 | $11.00 | $7.00 | $25,068.78 |
| 2 | Patrick H. Sweeney, Jeffersonville, Ind | 17.75 | 13.75 | 11.75 | 7.75 | 26,845.60 |

Contract awarded to Eigenmann & Hollerbach.

*Abstract of proposal received and opened May 8, 1893, by Maj. D. W. Lockwood, Corps of Engineers, for furnishing cement for improving Green River, Kentucky—rebuilding Lock No. 2.*

| No. | Name and address of bidder. | 1,500 barrels American natural cement. | Total. |
|---|---|---|---|
| | | *Per barrel.* | |
| 1 | J. B. Speed & Co., Louisville, Ky | $1.34½ | $2,017.50 |

Contract awarded J. B. Speed & Co.

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NOTE.—For commercial statistics and list of boats, see report for Operating and Care, etc., Green and Barren rivers, Kentucky.

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## I I 3.

## IMPROVEMENT OF GREEN RIVER, KENTUCKY, ABOVE MOUTH OF BIG BARREN RIVER (LOCK No. 5).

The river and harbor act of July 13, 1892, contained the following:

> Improving Green River, Kentucky, above the mouth of the Big Barren River, for Lock No. 5, according to report and recommendation of Maj. D. W. Lockwood, Corps of Engineers, U. S. Army, submitted August 11, 1891, $50,000.

This work having been assigned to me by Department letter of July 14, 1892, calling for a project for expenditure of the amount appropriated under date of July 25, 1892, I had the honor to state as follows:

> Before any definite project can be submitted it will be necessary to locate the site of the lock, as the old locations have been but approximate. This will be done at an early date, when plans, etc., for the lock and dam, together with plats of land required, will be submitted for approval.

A location for this lock was originally selected by Mr. Alonzo Livermore, State engineer of Kentucky, about fifty years ago. The point selected was at Floyds Landing, 20½ miles above Lock No. 4, Green River. In 1879 an examination was made by Mr. R. H. Fitzhugh, under the orders of the late Lieut. Col. William E. Merrill, Corps of Engineers, with a view to selecting a site for this lock, and he adopted the selection made by Livermore, with an alternate location just below the mouth of Bear Creek.

The Upper Green runs through a sandstone country and the stream has, in most places, eroded for itself a deep channel; as a consequence, rock is found only at a considerable depth below the water surface, and in many places borings to a depth of over 20 feet develop only sand and gravel.

The selection at Floyds Landing would place the lock against an almost perpendicular cliff, in very deep water, and was not deemed suitable on that account, as it would be impossible to set the land wall of the lock inside the ordinary bank line, and the spill of the dam would be necessarily short. The alternate selection of Mr. Fitzhugh, below the mouth of Bear Creek, would necessitate a gravel foundation for both lock and dam, and, besides, the natural banks in the vicinity are not above high water on either side.

Investigations were started to determine the fitness of a location near Honakers Ferry, but the lateness of the season and high water prevented a definite conclusion being reached. I believe this latter locality the most favorable of any in the vicinity. The final selection will be made as soon as the river reaches a low stage.

I would state that the final cost of the work would be much reduced if sufficient money could be appropriated to at least complete the lock and abutment in one season.

APPROPRIATION.

| | |
|---|---|
| July 13, 1892 | $50,000 |

*Money statement.*

| | |
|---|---|
| Amount appropriated by act approved July 13. 1892 | $50,000.00 |
| June 30, 1893, amount expended during fiscal year | 596.02 |
| July 1, 1893, balance unexpended | 49,403.98 |
| Amount (estimated) required for completion of existing project | 130,673.20 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895 | 130,673.20 |
| Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893. | |

NOTE.—For commercial statistics and list of boats, see report for Operating and Care, etc., Green and Barren rivers, Kentucky.

## I I 4.

### OPERATING AND KEEPING IN REPAIR LOCKS AND DAMS ON GREEN AND BARREN RIVERS, KENTUCKY.

The United States acquired possession of the locks and dams December 11, 1888, by purchase of the unexpired lease of the Green and Barren River Navigation Company, the legislature of the State of Kentucky having ceded them, with lands and appurtenances pertaining thereto, to the United States upon condition that the latter should extinguish the claim of the Navigation Company to take tolls and to exercise control over said rivers.

At the time of acquiring possession four of the locks were being operated, to wit, Nos. 1, 2, and 4, Green River, and No. 1, Barren River. The river wall of No. 3, Green River, was down, having fallen into the river about the first of the year. Both walls of No. 2 were, and had been for years, in a dilapidated condition, the land wall being prevented from tumbling into the pit only by reason of being anchored back to cribs filled with stone. At No. 1, Barren, the grillage upon which the walls rested had been undermined at the lower end of the hand wall, so that the wall was badly cracked and appeared liable to yield at any time. The dams were nearly all in bad condition, the timber of the downstream slopes being badly decayed.

The walls at No. 3, Green, and No. 1, Barren, were completed in time to reopen the river to through navigation November 10, 1890. The dams of No. 1, Barren, and No. 2, Green, have been rebuilt entirely from the crests forward, and the latter has been straightened by taking out the break in direction that formerly existed, and which made a forebay for logs for a small mill on the abutment side of the river. This dam now extends directly across the river from the lock. The old guide-cribs at upper and lower entrances of the locks had become useless by reason of their tumbled-down condition; these have been rebuilt, and the amount of dredging required after every rise has been materially lessened. The areas immediately behind the land walls of locks have been graded and paved, the United States land sown with grass seed and fenced in. Eight lock-keeper's dwellings have been built and two old ones put in thorough repair. At Lock No. 3 there has been an extensive cutting away of the bank just below the lock. The lower guide crib at this point will have to be extended, and it is proposed to construct two or three short spur dikes below, extending to top of bank, to stop further erosion.

An appropriation of $65,000 having been made in the last river and harbor bill for rebuilding Lock No. 2, work has been commenced, and the building of this lock will insure continuous navigation between the Ohio and Bowling Green.

It has been the practice for years for boats to enter the locks from below during very low water, drawing more water than there was on the lower miter sill, particularly at No. 1, Green. At times hours would be spent backing in, only a few feet being made at a time as the motion of the wheel would soon lower the water in the chamber. The boat would thus drag her whole length over the miter sill. Hereafter, however, boats will not be permitted to enter a lock drawing more water than there is on the sills.

During a part of the year Lock No. 2 was closed except for the passage of rafts and barges, and these were hauled through by hand, no one being permitted to stay on them. At present craft of every kind are permitted to go through, but no one is permitted to stay on board during the passage through the lock.

During the early part of June a rise occurred in Green River which overflowed the bottom lands. The water staid up for some time so that the banks were thoroughly saturated, and as a result many land slides have occurred, particularly in pools 1 and 2. The 9 miles of river below Lock No. 2 are now almost impassable.

The weight of the trees, now in full foliage, caused the weakened banks to give away, and this trouble was increased by the wind.

For a detailed account of work done during the past year, attention is respectfully invited to the report of Lieut. J. J. Meyler, Corps of Engineers, appended hereto.

*Leases in force for year ending June 30, 1893.*

| Location. | Lessee. | Date. | To expire. |
|---|---|---|---|
| Lock No. 2, Green | Livers & Welborn | Jan. 1, 1892 | Jan. 1, 1912 |
| Lock No. 2, Green | James Cate | Jan. 1, 1892 | Jan. 1, 1912 |
| Lock No. 1, Barren | William Boulton | July 1, 1878 | July 1, 1898 |

*Collections for Green and Barren rivers for year ending June 30, 1893.*

| Lessees. | Location. | Subject. | Amount collected. |
|---|---|---|---|
| Bryant & Nall | Lock No. 2, Green River | Land and water power | $150.00 |
| Livers & Welborn | do | do | 100.00 |
| James Cate | do | do | 100.00 |
| G. D. Hemenway | Lock No. 3, Green River | do | 47.92 |
| Hudnall & Cole | Lock No. 4, Green River | do | 150.00 |
| William Boulton | Lock No. 1, Barren River | do | 150.00 |

The leases with Bryant & Nall, G. D. Hemenway, and Hudnall & Cole are verbal ones made from year to year.

## APPROPRIATIONS.

| | |
|---|---|
| August 11, 1888, for purchase | $135,000.00 |

## ALLOTMENTS.

| | |
|---|---|
| January 4, 1889 | $167,112.00 |
| July 20, 1889 | 139,110.00 |
| July 17, 1890 | 53,783.47 |
| July 16, 1891 | 77,807.26 |
| July 15, 1892 | 46,264.26 |
| Total | 484,076.99 |

*Detailed statement of expenses incurred in preserving and maintaining navigation on that portion of the Green and Barren rivers, Kentucky, improved by locks and dams during the fiscal year ending June 30, 1893.*

| Months. | Lock No. 1, Green River. | | | | Lock No. 2, Green River. | | | |
|---|---|---|---|---|---|---|---|---|
| | Salaries. | Labor and material. | Current and contingent expenses. | Total. | Salaries. | Labor and material. | Current and contingent expenses. | Total. |
| **1892.** | | | | | | | | |
| July | $247.00 | $46.75 | $15.67 | $309.42 | $247.00 | $10.60 | $34.08 | $291.68 |
| August | 187.00 | 1,330.28 | 43.27 | 1,560.55 | 282.00 | 296.82 | 36.23 | 615.05 |
| September | 257.00 | 2,696.19 | 34.93 | 2,988.12 | 257.00 | 1,349.51 | 23.63 | 1,630.14 |
| October | 257.00 | 1,521.37 | 48.29 | 1,826.66 | 257.00 | 615.40 | 46.96 | 919.36 |
| November | 257,00 | 81.14 | 6.00 | 344.14 | 257.00 | 32.80 | 18.37 | 308.17 |
| December | 257.00 | 7.45 | 53.01 | 317.46 | 257.00 | 33.15 | 27.18 | 317.33 |
| **1893.** | | | | | | | | |
| January | 257.00 | .......... | 6.00 | 263.00 | 257.00 | 14.50 | 6.00 | 277.50 |
| February | 297.00 | 83.00 | 12.12 | 392.12 | 297.00 | 3.00 | 16.05 | 316.05 |
| March | 210.00 | 35.00 | 27.57 | 272.57 | 210.00 | 19.38 | 27.57 | 256.95 |
| April | 253.58 | 37.80 | 29.53 | 320.91 | 253.58 | 4.80 | 34.57 | 292.95 |
| May | 223.00 | 8.40 | 6.00 | 237.40 | 223.00 | 41.00 | 22.43 | 286.43 |
| June | 202.00 | .......... | 28.26 | 230.26 | 202.00 | 104.60 | 28.26 | 334.86 |
| Total | 2,904.58 | 5,847.38 | 310.65 | 9,062.61 | 2,999.58 | 2,525.56 | 321.33 | 5,846.47 |

| Months. | Lock No. 3, Green River. | | | | Lock No. 4, Green River. | | | |
|---|---|---|---|---|---|---|---|---|
| | Salaries. | Labor and material. | Current and contingent expenses. | Total. | Salaries. | Labor and material. | Current and contingent expenses. | Total. |
| **1892.** | | | | | | | | |
| July | $247.00 | $476.49 | $15.68 | $739.17 | $247.00 | $2.70 | $15.68 | $265.38 |
| August | 282.00 | 61.75 | 21.10 | 364.85 | 282.00 | 1,831.86 | 14.83 | 2,128.69 |
| September | 257.00 | 66.60 | 31.13 | 354.73 | 257.00 | 3,418.67 | 31.13 | 3,706.80 |
| October | 257.00 | 52.40 | 16.69 | 326.09 | 257.00 | 1,291.47 | 39.07 | 1,587.54 |
| November | 257.00 | 26.70 | 13.27 | 296.97 | 257.00 | 211.20 | 8.50 | 476.70 |
| December | 257 00 | 36.00 | 34.68 | 327.68 | 257.00 | 7.50 | 40.43 | 304.93 |
| **1893.** | | | | | | | | |
| January | 257.00 | .......... | 6.00 | 263.00 | 257.00 | 26.95 | 6.00 | 289.95 |
| February | 297.00 | 3.00 | 10.13 | 310.13 | 297.00 | .......... | 10.13 | 307.13 |
| March | 210.00 | 37.25 | 27.57 | 274.82 | 210.00 | 5.00 | 29.07 | 244.07 |
| April | 253.58 | 2.25 | 35.43 | 291.26 | 253.59 | 6.40 | 16.17 | 276.16 |
| May | 223.00 | 311.17 | 20.98 | 555.15 | 223.00 | .......... | 20.97 | 243.97 |
| June | 202.00 | 265.23 | 43.26 | 510.49 | 202.00 | .......... | 43.27 | 245.27 |
| Total | 2,999.58 | 1,338.84 | 275.93 | 4,614.34 | 2,999.59 | 6,801.75 | 275.25 | 10,076.59 |

*Detailed statement of expenses incurred in preserving and maintaining navigation on that portion of the Green and Barren rivers, Kentucky, etc.*—Continued.

| Months. | Lock No. 1, Barren River. Salaries. | Labor and material. | Current and contingent expenses. | Total. | United States snag boat Wm. Preston Dixon. Salaries and labor. | Repairs. | Subsistence. | Supplies. | Total. |
|---|---|---|---|---|---|---|---|---|---|
| 1892. | | | | | | | | | |
| July | $247.00 | ........ | $18.08 | $265.08 | $762.82 | $37.45 | $159.75 | $178.89 | $1,138.91 |
| August | 282.00 | $138.30 | 27.23 | 447.53 | 867.33 | 24.90 | 160.68 | 186.30 | 1,239.21 |
| September | 257.00 | 19.60 | 31.13 | 307.73 | 825.68 | 23.86 | 135.78 | 78.21 | 1,063.53 |
| October | 257.00 | 53.90 | 20.27 | 331.17 | 821.33 | ........ | 128.74 | 166.70 | 1,116.77 |
| November | 257.00 | 10.00 | 6.00 | 273.00 | 551.83 | ........ | 27.95 | 110.87 | 690.65 |
| December | 257.00 | ........ | 34.68 | 291.68 | 435.00 | 11.25 | ........ | 18.00 | 464.25 |
| 1893. | | | | | | | | | |
| January | 257.00 | 39.00 | 6.00 | 302.00 | 450.00 | ........ | ........ | ........ | 450.00 |
| February | 297.00 | ........ | 10.13 | 307.13 | 267.50 | 87.35 | 17.28 | ........ | 372.13 |
| March | 210.00 | 23.43 | 27.56 | 260.99 | 480.00 | 138.65 | 57.39 | 119.45 | 795.49 |
| April | 253.59 | ........ | 52.01 | 305.60 | 586.50 | 188.86 | 93.42 | 158.65 | 1,027.43 |
| May | 223.00 | ........ | 6.00 | 229.00 | 694.33 | 66.07 | 39.95 | 129.35 | 929.70 |
| June | 202.00 | 3.60 | 43.27 | 248.87 | 731.15 | 39.88 | 227.38 | 138.48 | 1,136.89 |
| Total | 2,999.59 | 287.83 | 282.36 | 3,569.78 | 7,473.47 | 618.27 | 1,048.32 | 1,284.90 | 10,424.96 |

| Months. | United States dredge boat Lermond. Salaries and labor. | Repairs. | Supplies. | Total. |
|---|---|---|---|---|
| 1892. | | | | |
| July | $364.25 | ........ | $11.79 | $376.04 |
| August | 346.50 | $8.53 | 56.94 | 411.97 |
| September | 385.00 | 91.00 | 55.78 | 531.78 |
| October | 385.00 | ........ | 69.22 | 454.22 |
| November | 178.50 | 2.90 | 1.98 | 183.38 |
| December | 145.00 | ........ | ........ | 145.00 |
| 1893. | | | | |
| January | 145.00 | ........ | ........ | 145.00 |
| February | 145.00 | 21.20 | ........ | 166.20 |
| March | 187.00 | 7.52 | 12.65 | 207.17 |
| April | 224.83 | ........ | 77.15 | 301.98 |
| May | 332.17 | 23.72 | 69.67 | 425.56 |
| June | 152.67 | ........ | 52.96 | 205.63 |
| Total | 2,990.92 | 154.87 | 408.14 | 3,553.93 |

## SUMMARY.

| | |
|---|---|
| Lock No. 1, Green River | $9,062.61 |
| Lock No. 2, Green River | 5,846.47 |
| Lock No. 3, Green River | 4,614.81 |
| Lock No. 4, Green River | 10,076.50 |
| Lock No. 1, Barren River | 3,569.78 |
| United States snag boat Wm. Preston Dixon | 10,424.96 |
| United States dredge boat Lermond | 3,553.93 |
| Grand total | 47,148.68 |

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## REPORT OF FIRST LIEUT. JAMES J. MEYLER, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
*Bowling Green, Ky., June 30, 1893.*

MAJOR: I have the honor to submit the following report of operations on Green and Barren rivers, Kentucky, for the fiscal year ending June 30, 1893.

The work on these streams is carried on under the "indefinite appropriation for operating and care of canals and other works of navigation."

## WORK DONE.

### LOCK AND DAM NO. 1, GREEN RIVER.

*Repairs to dam.*—Repaired 140 linear feet of dam, removing old sheeting from upper and lower slopes, and old timber and stone from dam, and putting in new timber, stone, and sheeting throughout the section.

*General work.*—Constructed a small crib under discharge of drain pipe; backed dam with 1,000 cubic yards of hickory lathe sawdust to stop leaks; dredged lock pit and entrances to lock; stopped leaks in old culvert with stone from cofferdam, and 96 linear feet of timber placed in same; hewed 1,442 linear feet of timber; hoisted 7,763 linear feet of timber on island and stacked same.

### LOCK AND DAM NO. 2, GREEN RIVER.

*Repairs to lock.*—Pumped out lock pit and took out lower miter sills and sheeting for gate bay; put in new miter sills and new sheeting for gate bay and repaired upper and lower gates; reänchored lower river gate, and reset heel block to same; repaired windless chain and anchor rod.

*Repairs to dam.*—Placed 60 linear feet of comb stick on dam; placed 600 cubic yards of hickory lathe sawdust backing behind dam to stop leaks.

*General work.*—Dredged entrances to lock; hewed 500 linear feet of timber.

### LOCK AND DAM NO. 3, GREEN RIVER.

*General work.*—Prepared, drove, and capped 1,335 linear feat of piling, forming fender for crafts entering lock from above; prepared bank for sodding, and cut, hauled, and laid 1,400 cubic yards of sod on same; set 50 linear feet of stone curbing, and constructed brick walk from lock-keeper's dwellings to lock; removed broken cast bonnet from lower-river gate and put on new one; scraped and dredged upper entrance to same.

### LOCK AND DAM NO. 4, GREEN RIVER.

*Repairs to dam.*—Repaired 70 linear feet of upper slope of dam, tearing away old sheeting and putting on new.

*Abutment.*—Excavated and tore out 1,125 cubic yards of timber, stone, and earth from old abutment; built new timber abutment and wing and filled same with stone, quarrying 430 cubic yards for that purpose.

*General work.*—Repaired apron to dam, placing in same 800 linear feet of timber and 360 cubic yards of stone, and covering same (90 feet by 27 feet) with new sheeting; reset anchors to upper shore lock gate, putting in two new dimension stone; dredged and scraped lock pit and dredged entrances to lock; blasted and removed 350 cubic yards of stone from ledge below lock; built new tool house to replace one destroyed by fire on October 19, 1892.

### LOCK AND DAM NO. 1, BARREN RIVER.

*General work.*—Hung one new lower lock gate; placed 2,050 cubic yards of backing, of gravel and sand, behind dam to stop leaks; dredged entrances to lock.

### UNITED STATES DREDGE BOAT B. O. LERMOND.

*Lock No. 1, Green River.*—Dredged and removed 4,960 cubic yards of material and 2 logs from lock pit and entrance to lock.

*Lock No. 2, Green River.*—Removed 8,335 cubic yards of material from lock pit and upper and lower chutes; removed one cofferdam upon completion of lower miter sills and repairs to gates; removed 5,725 cubic yards of material; tore away and removed 3,386 linear feet of old cribbing, and raised and removed 7 saw logs and large sycamore snag from site of proposed upper dam to inclose new lock.

*Lock No. 3, Green River.*—Dredged and removed 200 cubic yards of material from lock pit and upper entrance to lock.

*Lock No. 4, Green River.*—Dredged and removed 5,465 cubic yards of material from lock pit and entrances to lock; blasted, dredged, and removed 350 cubic yards of stone from ledge below lock.

*Lock No. 1, Barren River.*—Dredged and removed 4,975 cubic yards of material and 151 logs and stumps from lock pit and entrances to lock.

*General work.*—Dredged and removed 750 cubic yards of material from Light Water Bar, below lower entrance to Lock No. 1, Barren River, changing and straightening channel of approach to lock; dredged off point of Boat Island, removing 6,600 cubic yards of material, and widened channel at Robinson's Island, removing 1,200 cubic yards of material from point; painted and repaired dredge, and calked ends of dump scows.

### UNITED STATES SNAG BOAT WM. PRESTON DIXON.

Removed 1,004 snags, weighing 1,675 tons, from channel of river, and cut on shore 166 overhanging trees; removed 289 pieces of old crib timber from Light Water Bar, below Lock No. 1, Barren River; made soundings on Upper Green River between Lock No. 4 and Floyds Landing for the purpose of locating site for new lock; took out old lock gate at Lock No. 1, Barren River, and hung new gate; removed cofferdam above Lock No. 2, Green River, and pulled one dump scow out on bank for repairs; placed backing behind dams to stop leaks, as follows, viz: 1,000 cubic yards of sawdust at No. 1, Green River; 600 cubic yards of sawdust at No. 2, Green River; and 2,050 cubic yards of gravel at No. 1, Barren River. Painted and repaired snag boat; did all necessary towing on Green and Barren Rivers; towed Wabash River dredge from mouth of Kentucky River to Mount Carmel, Ill. Total miles run, 6,203.

Very respectfully, your obedient servant,

JAMES J. MEYLER,
*First Lieutenant of Engineers.*

Maj. D. W. LOCKWOOD,
*Corps of Engineers, U.S. Army.*

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### COMMERCIAL STATISTICS.

*Green and Barren rivers, Kentucky, for fiscal year ending June 30, 1893.*

| Articles. | 1890. | 1891. | 1892. | 1893. |
|---|---|---|---|---|
| | *Tons.* | *Tons.* | *Tons.* | *Tons.* |
| Barrels, empty | 55 | 52 | 1,308 | [illegible] |
| Beer | 1,245 | 222 | 92 | 61 |
| Cement | 168 | 600 | 83 | 17 |
| Coal | 45,904 | 49,000 | 71,431 | 78,[illegible] |
| Flour | 773 | 1,363 | 1,540 | 1,[illegible] |
| Grain | 1,431 | 1,284 | 2,956 | 3,[illegible] |
| Handles | 227 | 6,144 | 606 | [illegible] |
| Hay | 819 | 427 | 1,106 | [illegible] |
| Hides | 19 | 30 | 233 | 46 |
| Hoop poles | 278 | 770 | 4,342 | 1,[illegible] |
| Iron, manufactured | 98 | 253 | 186 | 4 |
| Live stock | 482 | 1,285 | 2,066 | 2,[illegible] |
| Lumber | 2,866 | 9,000 | 14,565 | 14,548 |
| Merchandise | 8,933 | 16,420 | 13,093 | 9,[illegible] |
| Produce | 501 | 184 | 364 | 342 |
| Salt | 1,014 | 1,104 | 1,376 | 1,[illegible] |
| Stone | 788 | 14,752 | 10,742 | 4,[illegible] |
| Staves and heading | .......... | 744 | 7,841 | 3,[illegible] |
| Ties, railroad | 16,373 | 21,325 | 40,736 | 34,[illegible] |
| Tobacco, leaf | 4,723 | 2,164 | 1,868 | 2,[illegible] |
| Timber, logs, etc | 819,920 | 500,000 | 283,911 | [illegible] |
| Whisky | 57 | 42 | 51 | 54 |
| Passengers | 972 | 1,434 | 1,613 | 1,[illegible] |
| Total | 907,146 | 628,600 | 462,208 | 614,[illegible] |

*List of boats plying on Green and Barren rivers, Kentucky.*

| Name of boat. | Character. | Length. | Breadth. | Depth. | Tonnage. |
|---|---|---|---|---|---|
| | | *Feet.* | *Feet.* | *Feet.* | |
| Evansville | Passenger | 121 | 30 | 5 | 194.25 |
| Rescue | do | 121 | 26.8 | 3.4 | 139.30 |
| J. C. Kerr | do | 120 | 21.0 | 3.7 | 121.15 |
| Fannie | do | 85.4 | 18.4 | 3.7 | 80.90 |
| T. C. Woodward | do | 63 | 9 | 4 | 33.50 |
| Mary Stewart | do | 100 | 20 6 | 3.6 | 90.20 |
| Lela | do | 70 | 18 | 3 | 63.27 |
| Eugene | Towboat | 113 | 20 | 3.5 | 98.31 |
| Longfellow | do | 112 | 19.6 | 4.3 | 93.59 |
| D. A. Nisbet | do | 105 | 20 | 3.6 | 64.68 |
| G. B. Monteith | do | 103.4 | 18.2 | 2.9 | 62.91 |
| Little Clyde | do | 100 | 20 | 3.6 | 52.20 |
| I. N. Hook | do | 109 | 19.4 | 3 | 55.95 |
| Emma Cooper | do | 95 | 25 | 3.5 | 79.10 |
| Troubadour | do | 93.4 | 18 | 3 | 61.37 |
| Little Tom Moss | do | 90 | 22 | 3 | 56.30 |
| Co | do | 81.6 | 15.7 | 2.7 | 19.84 |
| Eleanor | do | 60 | 16 | 2.8 | 14.64 |
| Little Albert | do | 64.5 | 19.9 | 2.9 | 24.53 |
| Isabella | Tugboat | 95 | 22 | 4.8 | 66.24 |
| Louise | do | 73 | 16.5 | 3.8 | 40.80 |
| Emma Erwin | do | 79 | 15 | 4.4 | 41.84 |
| Ingleside | do | 81 | 14 | 4 | 36.00 |
| Orphan Girl | do | 80 | 15 | 4 | 39.00 |
| Uncle Buck | do | 67 | 18 | 4 | 32.34 |
| Wm, Preston Dixon | United States snagboat | 123.6 | 32 | 5 | 200.00 |
| Ida | Towboat | 60 | 14 | 3 | 22.00 |

*Report of lockages on Green and Barren rivers, Kentucky, for fiscal year ending June 30, 1893.*

| Locks. | Days operated. | Days suspended. | Going up. | | | Going down. | | | | Total crafts and flats passing. | Total number lockages. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Steamboats. | Barges and flats. | Miscellaneous. | Steamboats. | Barges and flats. | Rafts. | Miscellaneous. | | |
| **Green River:** | | | | | | | | | | | |
| No. 1 | 278 | 87 | 411 | 254 | 99 | 412 | 252 | 914 | 62 | 2,404 | 2,743 |
| No. 2 | 271 | 94 | 154 | 193 | 8 | 150 | 186 | 715 | 1 | 1,437 | 1,889 |
| No. 3 | 327 | 38 | 252 | 135 | 127 | 257 | 134 | 560 | 122 | 1,587 | 2,316 |
| No. 4 | 337 | 28 | 276 | 161 | 81 | 277 | 172 | 292 | 63 | 1,321 | 1,640 |
| **Barren River:** | | | | | | | | | | | |
| No. 1 | 347 | 18 | 266 | 148 | 2 | 252 | 142 | 32 | 12 | 854 | 798 |
| **Total** | 1,560 | 265 | 1,359 | 891 | 317 | 1,348 | 886 | 2,643 | 260 | 7.603 | 9,386 |

Navigation through Lock No. 1, Green River, was suspended twelve days for ice and seventy-five days for high water; navigation through Lock No. 2, Green River, was suspended ten days for ice and fifty-four days for high water and thirty days for repairs; navigation through Lock No. 3, Green River, was suspended thirteen days for ice and twenty-five days for high water; navigation through Lock No. 4, Green River, was suspended ten days for ice and eighteen days for high water; navigation through Lock No. 1, Barren River, was suspended eleven days for ice and seven days for high water. Lock No. 2, Green River, was declared unsafe and closed to steamboats on August 3, 1892; it was opened again to steamboats on April 4, 1893, on condition that owners of same assume all risks of accident, and that nobody be allowed on the boat while same was in the lock.

## I I 5.

## IMPROVEMENT OF ROUGH RIVER, KENTUCKY.

Rough River is a tributary of Green River, emptying into it at a point 71 miles from its mouth, and 8 miles above Lock No. 2, at Rumsey.

Shortly after the war a company built a timber and stone lock, with dam and abutment, about 8 miles from the mouth of the river, and steamboats from 110 to 125 feet long ran up the river as far as Hartford, until the Green and Barren River improvements were leased to the Green and Barren River Navigation Company by the State of Kentucky. It is claimed that the excessive tolls charged by the Navigation Company effectually killed the commerce of Rough River, and the lock and dam were abandoned. The dam was only 90 feet long, and shortly afterwards the river cut around the abutment. Eventually the dam was torn out, so that now nothing but the ruins of the old lock remain.

The river was very much obstructed at the time work on it was commenced, and, being narrow and very crooked, some of the bends were almost filled with snags, sunken timber, and logs, while overhanging trees on the banks constituted a still further obstruction to steamboats.

The project for this improvement was approved October 27, 1890, and provides as follows: First. To definitely locate the site of the lock proposed, and purchase or have condemned the land needed about the lock and abutment. Second. Clear the river of obstructions, to wit, overhanging trees on the banks, and snags, logs, and stumps in the bed of the river. The estimate for this was $300 per mile, or $9,000 for the 30 miles between the mouth of the river and Hartford.

At the close of the last fiscal year the trees on the river banks had been deadened by girdling, and the channel of the river cleared of snags, sunken logs, drift heaps, etc. It is proposed to chop the deadened trees in the river as soon as they have sufficiently dried out to float.

The location, plans, etc., of the proposed lock were approved by the Chief of Engineers under date of August 31, 1891. The site of the lock is near that of the old one, 8 miles from the mouth of the river. The title to the land required on the lock and abutment sides of the river has been obtained.

On February 25, 1893, bids were received and opened, after due public advertisement, for furnishing stone for partial construction of the lock. Only three bids were received and those were all rejected as being too high, and the work was left to await further appropriation, when, with sufficient money to purchase all, or at least the greater part of the stone required, lower bids may be reasonably expected.

### APPROPRIATIONS.

| | |
|---|---|
| September 19, 1890 | $25,000 |
| July 13, 1892 | 15,000 |
| Total | 40,000 |

*Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $19,167.96 |
| Amount appropriated by act approved July 13, 1892 | 15,000.00 |
| | 34,167.96 |
| June 30, 1893, amount expended during fiscal year | 1,187.94 |
| July 1, 1893, balance unexpended | 32,980.02 |
| July 1, 1893, outstanding liabilities | 430.85 |
| July 1, 1893, balance available | 32,549.17 |
| Amount (estimated) required for completion of existing project | 65,556.05 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895 | 65,556.05 |
| Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893. | |

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*Abstract of bids received and opened February 25, 1893, by Maj. D. W. Lockwood, Corps of Engineers, for furnishing stone for improving Rough River, Kentucky.*

| No. | Name and address of bidder. | Special stone 108.42 cubic yards. | Cut stone dressed face 189.71 cubic yards. | Cut stone quarry face 306.10 cubic yards. | Backing stone 770.07 cubic yards. | Total. |
|---|---|---|---|---|---|---|
| | | *Per cu. yd.* | *Per cu. yd.* | *Per cu. yd.* | *Per cu. yd.* | |
| 1 | Fred. D. Hamilton and W. P. Koon, Louisville, Ky. | $18.00 | $12.00 | $10.00 | $7.50 | $13,064.60 |
| 2 | P. H. Sweeney, Jeffersonville, Ind | 23.00 | 16.25 | 13.50 | 11.00 | 15,946.35 |
| 3 | Eigenmann & Hollerbach, Cannelton, Ind | 16.10 | 14.10 | 12.10 | 8.10 | 14,361.84 |

All bids rejected.

*Commercial statistics of Rough River, Kentucky, for fiscal year ending June 30, 1893.*

| Articles. | 1891. | 1892. | 1893. |
|---|---|---|---|
| | *Tons.* | *Tons.* | *Tons.* |
| Logs | 89,161 | | |
| Lumber | 9,000 | | |
| Timber, logs, etc | | 50,000 | 75,000 |
| Total | 98,000 | 50,000 | 75,000 |

*List of boats plying on Rough River, Kentucky.*

[Character, tugboat.]

| Name of boat. | Length. | Breadth. | Depth. | Tonnage. |
|---|---|---|---|---|
| | *Feet.* | *Feet.* | *Feet.* | |
| Uncle Buck | 67 | 18 | 4 | 30.34 |

## I I 6.

## IMPROVEMENT OF KENTUCKY RIVER, KENTUCKY.

The Kentucky River is a tributary of the Ohio, and empties into it at Carrollton, Ky., about midway between Cincinnati, Ohio, and Louisville, Ky.

The present project for the improvement of the river was adopted in 1879, the object being to repair the five locks and dams built by the State of Kentucky, and extend slack-water navigation for a draft of 6 feet, by the construction of additional locks and dams, to Beattyville, a distance of 261 miles from the mouth of the river.

### WORK DONE DURING THE YEAR.

*Lock No. 6.*—This lock was completed so as to permit the passage of boats, December 2, 1891, and money expended on it since then has been for the purpose of filling in behind the land wall, grading and paving the slope leading up to the level of high water, the construction of upper and lower land and river guide cribs, and in reënforcing the apron of the dam.

For details concerning the amount and character of work done during the past year, attention is invited to the report of Lieut. H. B. Waterman, Corps of Engineers, appended hereto.

*Beattyville Dam.*—This dam, which had in previous years been cut down to the level of the second step and extended through the old passes and bear-traps to the Proctor side of the river, has remained in pretty much the same condition it was in at the end of the last fiscal year.

A railroad has been built from Beattyville to connect with the Kentucky Union Railroad, so that the dam is now unnecessary, and is, in fact, an obstruction to the running of rafts. In my opinion it will not be advisable to expend any more money in maintaining this obstruction.

*Lock No. 7.*—During the past year several locations have been examined for the site of this lock, but owing to high water it was impossible to definitely fix the site; but it seems probable, at the present time, that the best location would be about $\frac{3}{8}$ of a mile below High Bridge. As soon as the river reaches a suitable stage to enable the character of the bottom and distance to rock to be determined the site will be definitely fixed.

*Snag boat Kentucky.*—The snag boat *Kentucky*, by reason of her age and hard usage, having become practically unfitted for the work required of her, authority was granted to construct a new towboat to take her place. The time for completion has been extended twice, and it is now hoped that she will be available for service by August 1.

*Abstract of contract for improving Kentucky River, Kentucky, in force during the fiscal year ending June 30, 1893.*

| Contractor. | Nature of contract. | Date. | To expire. | Remarks. |
|---|---|---|---|---|
| Chas. Barnes .......... | Construction of boat ............. | Nov. 9, 1892 | Nov. 1, 1893 | Extended to Aug. 1, 1893. |

### APPROPRIATIONS.

| | |
|---|---|
| March 3, 1879 | $100,000 |
| June 14, 1880 | 100,000 |
| March 3, 1881 | 125,000 |
| August 3, 1892 | 225,000 |
| July 5, 1884 | 250,000 |
| August 5, 1886 | 187,500 |
| August 11, 1888 | 180,000 |
| September 19, 1890 | 180,000 |
| July 13, 1892 | $150,000 |
| Total | 1,497,500 |
| Received from Taber and Cogar | 500 |
| Total | 1,498,000 |

### *Money statement.*

| | | |
|---|---|---|
| July 1, 1892, balance unexpended | | $3,982.16 |
| Amount appropriated by act approved July 13, 1892 | | 150,000.00 |
| | | 153,982.16 |
| June 30, 1893, amount expended during fiscal year | | 47,584.49 |
| July 1, 1893, balance unexpended | | 106,397.67 |
| July 1, 1893, outstanding liabilities | $3,337.01 | |
| July 1, 1893, amount covered by uncompleted contracts u.. | 17,240.00 | |
| | | 20,577.01 |
| July 1, 1893, balance available | | 85,820.66 |
| Amount (estimated) required for completion of existing project | | 1,524,000.00 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895 | | 500,000.00 |

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

*Abstract of proposals received and opened November 1, 1892, by Maj. D. W. Lockwood, Corps of Engineers, for construction of a tow and snag boat for Kentucky River.*

| No. | Name and address of bidder. | Total price bid. |
|---|---|---|
| 1 | M. A. Sweeney Company, Jeffersonville, Ind | $19,500 |
| 2 | Sam'l W. Coflin & Son, Cincinnati, Ohio | 17,647 |
| 3 | Chas. E. Ehler, Cincinnati, Ohio | 23,750 |
| 4 | Chas. Barnes, Cincinnati, Ohio | 16,800 |

Contract awarded to Charles Barnes.

NOTE.—For list of boats plying the Kentucky River and for commercial statistics for Kentucky River, see report for operating and care of canals, etc., as applied to Kentucky River.

## REPORT OF FIRST LIEUT. H. E. WATERMAN, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
*Frankfort, Ky., June 30, 1893.*

MAJOR: The opening of the past fiscal year found the lock and dam at No. 6 finished, but on account of lack of funds very little had been done on the crib approaches or grading ground. During the past year all work under improving Kentucky River has consisted in completing these accessories.

Some expensive stone cutting and an immense amount of filling behind the land wall was necessary to put the lock in good working condition.

Work really did not begin until the middle of September.

It is proper to add that the delay and extra expense caused by the eight-hour law should be taken into consideration. This extra cost on all work must be about 20 or 25 per cent. But this is not so important as the great loss of time involved. The present working hours are from 7 a. m. to 12 a. m., and from 1 p. m. to 4 p. m., causing, practically, a loss of from two to four hours daily through the summer season.

Lastly, work on the crib work has been greatly delayed by failure of contractors to supply the necessary timber.

As a result of the season's work, the grading of the grounds, lower land wall, and foundation of the first lock house are about complete. The cistern for this house, roadway into the grounds, and paving behind walls are finished.

The stone steps up the center of the slope and lower river wall are expected to be about complete by the end of July.

There will still be necessary the upper river wall, the brick walks in the lock-house ground, the foundation and spring house for the second lock house, and the construction of two lock-keepers' dwellings.

Several surveys have been made during the past year to determine the site of Lock No. 7, but the matter is still in an unsettled state. It is hoped that as soon as the water reaches a low stage that this matter may be decided and the purchase of necessary grounds completed.

The following is a detailed statement of the work for the past year:

## LOCK NO. 6.

### *Lock.*

*Lower entrance.*—Dredged 10,693 cubic yards of sand and gravel, widening and deepening channel; blasted and removed 389 cubic yards of rock.

*Lower guide wall.*—Excavated for foundation 665 cubic yards of earth and clay; tore out 360 linear feet of timber laid in 1891. Laid the following amount of timber in wall:

| | Feet, B. M. |
|---|---|
| 212 pieces 6 by 12 inches by 16 feet | 20, 352 |
| 78 pieces 6 by 12 inches by 20 feet | 9, 360 |
| 38 pieces 6 by 12 inches by 24 feet | 5, 472 |
| 28 pieces 6 by 12 inches by 30 feet | 5, 040 |
| 5 pieces 10 by 10 inches by 10 feet | 416 |
| 196 pieces 10 by 10 inches by 16 feet | 26, 133 |
| 89 pieces 10 by 10 inches by 20 feet | 14, 833 |
| 122 pieces 10 by 10 inches by 24 feet | 24, 400 |
| 53 pieces 10 by 10 inches by 30 feet | 13, 250 |
| 56 pieces 10 by 10 inches by 32 feet | 14, 933 |
| Old timber | 3, 516 |
| Total | 137, 705 |

Used 3,066 spikes ¾ by 16 inches and 1,438 spikes ¾ by 24 inches. Placed in crib as ballast 2,005 cubic yards of riprap; placed behind wall as filling 3,079 cubic yards of earth, small stones, and spalls.

*Lower river wall.*—Dredged for foundation of lower river wall 3,105 cubic yards of sand and gravel.

*Upper guide wall.*—Placed in crib 353 cubic yards of riprap for ballast; placed behind crib, for filling, 1,962 cubic yards of earth, small stones, and spalls.

### *Prolongation of breast walls.*

*Upper breast wall.*—Excavated for foundation, 912 cubic yards of earth; laid in foundation, 2,328 feet, B. M., 6 by 12 inch oak timber; set in wall 367 cubic yards of backing, 64 cubic yards of broken stone and spalls, and 12 cubic yards of coping.

*Lower breast wall.*—Excavated for foundation, 1,568 cubic yards of earth; set in wall, 413 cubic yards of backing, 102 cubic yards of broken stone, and 14 cubic yards of coping; cut in yard, 282 square feet of slope stone to set coping on, and 24 cubic yards of coping.

### *Grading and filling.*

*Inside lock wall.*—Placed behind land wall, 12,904 cubic yards of earth, small stones, spalls, sand, and gravel.

*Lock grounds.*—Handled 6,036 cubic yards of material grading grounds.

*Roadway.*—Constructed a road from end of upper breast wall to gate at Versailles turnpike near the Oregon Ferry. The road is 4,014 feet in length and an average width of 14 feet. Handled 1,765 cubic yards of earth grading and filling; ballasted it with 2,081 cubic yards of broken stone; constructed two bridges, one 29 feet and 5 inches long and 12 feet wide, the other bridge 22 feet and 2 inches long and 15 feet and 2 inches wide; also six culverts. Approaches to bridges and culverts required the building of 183 cubic yards of dry stone walls.

### *Masonry work.*

*Cistern.*—Built a cistern 19 feet deep, 12 feet in diameter; 44 cubic yards of rubble course masonry laid in its construction; laid on top of cistern 3 cubic yards 21 cubic feet of coping; laid 1 cubic yard 22 cubic feet of rubble masonry, building filter for cistern, 2 feet and 6 inches in diameter, 2 feet and 6 inches deep, 1 foot wall, and 10-inch bottom.

*Vault.*—Built vault in yard 19 by 5 feet, 4 by 3 feet 6 inches; dry walls 2 feet thick, containing 18 cubic yards and 20 cubic feet of masonry.

*Foundation for lock-keeper's dwelling.*—Laid 79 cubic yards of rubble masonry and 3 cubic yards of pitch-face masonry for foundation of lock house; laid 9 cubic yards of rubble masonry for chimney bases.

*General masonry work.*—Quarried and laid 885 square yards of slope paving; cut and laid 896 square feet of flagging.

*Steps in center of fill behind land wall.*—Cut and laid 76 square feet of Salem, Ind., stone for landing at base; cut and laid 460 square feet of Salem stone for steps; cut and laid 87 linear feet of curbing for steps; cut 23 square feet of Salem stone for steps; cut 16 linear feet of Salem stone for curbing.

*Recess for lock-gate spars.*—Cut and laid 170 cubic feet of rubble masonry, 76 linear feet of coping, and 261 square feet of flagging, making recess in slope wall for spars of upper and lower lock gates.

*General work.*—Watching and caring for barges, scows, and other Government property and material; receiving, conveying, and framing timbers for crib work; rigging derricks for handling timbers; furnishing fuel and pumping water for engines; general carpenter and blacksmith work; sharpening tools, repairing tools, machinery, and plant; calking boats and barges; bankering stone for cutters; repairing steam stone drills and stone cars; laid 865 linear feet of railroad track; raised and rigged six derricks; moved blacksmith shop and office to new location; moved 182 cubic yards of earth, digging trench on hill back of land wall to drain water below lower guide wall; built house around hoisting engine; hoisted from quarry and piled 65 cubic yards of cut stone; quarried 4,310 cubic yards of riprap for new shore and river cribs; quarried riprap for lower shore crib; general care and supervision of Government plant.

### BEATTYVILLE DAM.

Watching, care, and preservation of Government property.

### ROCK SHOAL QUARRY.

Watching, care, and preservation of Government property.

### U. S. SNAG BOAT KENTUCKY.

The U. S. snag boat *Kentucky* assisted in making surveys for the proposed site of Lock and Dam No. 7, and general work around Lock No. 6; towed cement from Louisville, Ky., and other material to the lock; acted as tender to dredges *Ward* and *Willie*.

### U. S. DREDGE WILLIE.

U. S. dredge *Willie* dredged 17,195 cubic yards of material from around Lock No. 6, and 900 cubic yards from bar at Clear Creek; overhauling and repairing machinery.

### U. S. DREDGE WARD.

U. S. dredge *Ward* dredged 550 cubic yards of material at Lock No. 6.

### U. S. DERRICK BOAT.

U. S. derrick boat assisted in handling and stacking timber at Lock No. 6.

Respectfully submitted.

H. E. Waterman,
*First Lieut. of Engineers.*

Maj. D. W. Lockwood,
*Corps of Engineers, U. S. A.*

## I I 7.

## OPERATING AND KEEPING IN REPAIR THE SIX LOCKS AND DAMS OF KENTUCKY RIVER, KENTUCKY.

The United States acquired possession of these locks and dams in 1880, at which date they were in a more or less crippled condition, the timber of the dams being badly decayed and the lock gates and operating machinery in such a state as to need absolute removal or extensive repairs.

Some of the dams have been entirely rebuilt, the others nearly so. Guide walls above and below the locks have been constructed, and the banks about the locks and abutments protected by timber cribbing to prevent erosion.

New lock-keepers' houses have been built, the areas in rear of the land walls graded and paved, and the grounds graded, sown with grass seed, and fenced.

With the completion of Lock and Dam No. 6, slack-water navigation was extended to High Bridge, which is 121 miles above the mouth of the Kentucky.

During the past fiscal year general repairs have been made to the dams, such as replacing sheeting torn off by drift and placing backing behind the upper breasts to stop leaks, etc.

The general repairs to the locks have consisted in replacing defective coping and repairing gates by putting in new blocks and arms. When necessary the entrances have been dredged, so as to afford navigation equal to the full depth on the lower miter sills, and the guide and protection cribs about the entrances have been kept in repair.

The river has been kept free from snags by the United States snag boat *Kentucky*, which, although belonging to the general improvement of the Kentucky River, is yet a large part of the time operated under the indefinite appropriation for operating and care of canals, etc., applied to Kentucky River, Kentucky. In her present condition this boat is far from being effective.

An additional lock-keeper's dwelling is required at Lock No. 2.

At Lock No. 1 there has for a number of years existed a bad leak next the abutment, the cause of which is somewhat obscure.

When the washout around the abutment occurred in November, 1881, a deep cut was made, and this cut was filled in with any kind of material that was available—trees, logs, stone, etc. The leak may come from seepage through this mass of material, or it may be due to the new breast built above the dam in 1887. A row of sheet piles at that time was driven across the river, 16 feet above the old breast, the space between the two being filled with clay, gravel, and stone, and then decked over. The clay has washed out and the decking is defective. It is proposed to remove this decking and fill in between the old and new breasts with riprap stone and gravel, so as to compact it.

Dam No. 3 has deteriorated considerably from natural decay, and will require extensive repairs.

Dam No. 5 leaks badly, and the trouble is due to the fact that when the dam was built by contract the foundation did not reach rock. This dam will have to be backed with stone and gravel.

Dam No. 6 will require an addition to the lower step and refilling with stone where needed. The trouble here is that the cribs constituting the lower step were not put down to rock.

For details of work done during the past year attention is invited to the report of Lieut. H. E. Waterman, herewith.

New lower gates are required at Locks Nos. 2, 3, and 4.

*Kentucky River, Kentucky, leases for year ending June 30, 1893.*

| Location. | Lessee. | Dated. | Expires. |
|---|---|---|---|
| Lock No. 4 | Kentucky River Mills | July 10, 1878 | July 10, 1977 |

This lease was made by the Commonwealth of Kentucky.

*Collections for Kentucky River, Kentucky, for year ending June 30, 1893.*

| Lessee. | Subject. | Amount collected. |
|---|---|---|
| Kentucky River Mills | Land and water power | $180 |

ALLOTMENTS.

| | |
|---|---|
| 1885 | $15,000.00 |
| 1886 | 24,000.00 |
| 1887 | 35,133.60 |
| 1888 | 82,308.54 |
| 1889 | 82,478.50 |
| 1890 | 72,394.80 |
| 1891 | $28,889.07 |
| 1892 | 48,826.68 |
| 1893 | 40,503.62 |
| Total | 429,534.81 |

*Detailed statement of expenses incurred in preserving and maintaining navigation on that portion of the Kentucky River, Kentucky, improved by locks and dams, during the fiscal year ending June 30, 1893.*

| Months. | Lock No. 1. | | | | Lock No. 2. | | | |
|---|---|---|---|---|---|---|---|---|
| | Salaries. | Labor and material. | Current and contingent expenses. | Total. | Salaries. | Labor and material. | Current and contingent expenses. | Total. |
| 1892. | | | | | | | | |
| July | $186.68 | $2,360.37 | $10.86 | $2,557.91 | $186.68 | $185.81 | $2.22 | $374.71 |
| August | 153.33 | 2,580.17 | 6.28 | 2,739.78 | 153.33 | 8.49 | 6.28 | 168.10 |
| September | 203.33 | 1,945.69 | 5.08 | 2,154.10 | 203.33 | 274.97 | 5.09 | 483.39 |
| October | 127.84 | 1,040.43 | 28.04 | 1,196.31 | 153.34 | 80.89 | 7.89 | 242.12 |
| November | 117.33 | 2,836.90 | 6.00 | 2,960.23 | 153.33 | 136.86 | 12.74 | 302.93 |
| December | 95.00 | 678.10 | 5.50 | 778.60 | 95.00 | 16.00 | 2.02 | 113.02 |
| 1893. | | | | | | | | |
| January | 95.00 | 9.00 | | 104.00 | 95.00 | | | 95.00 |
| February | 95.00 | 32.96 | 17.86 | 145.82 | 95.00 | | 3.05 | 98.05 |
| March | 95.00 | | | 95.00 | 95.00 | | | 95.00 |
| April | 95.00 | 2.75 | 10.28 | 108.03 | 95.00 | | 2.32 | 97.32 |
| May | 223.49 | 3.50 | 2.40 | 229.39 | 223.49 | | 2.40 | 225.89 |
| June | 136.67 | 15.00 | 1.60 | 153.27 | 136.67 | | | 136.67 |
| Total | 1,623.67 | 11,504.87 | 93.90 | 13,222.44 | 1,685.17 | 703.02 | 44.01 | 2,432.20 |

*Detailed statement of expenses incurred in preserving and maintaining navigation on that portion of the Kentucky River, Kentucky, etc.*—Continued.

| Months. | Lock No. 3. |  |  |  | Lock No. 4. |  |  |  |
|---|---|---|---|---|---|---|---|---|
|  | Salaries. | Labor and materials. | Current and contingent expenses. | Total. | Salaries. | Labor and materials. | Current and contingent expenses. | Total. |
| **1892.** |  |  |  |  |  |  |  |  |
| July | $186.66 | $168.06 | $2.22 | $356.94 | $186.66 | $129.51 | $2.23 | $318.40 |
| August | 153.34 | 43.50 | 6.29 | 203.13 | 153.34 | 51.06 | 6.29 | 210.69 |
| September | 203.33 | 778.92 | 5.09 | 987.34 | 203.33 | 32.80 | 5.10 | 241.23 |
| October | 153.33 | 400.15 | 4.78 | 558.26 | 153.33 | 21.35 | 10.28 | 184.96 |
| November | 153.34 | 280.31 | 5.05 | 438.70 | 153.34 | 48.93 | .......... | 202.27 |
| December | 95.00 | 8.17 | 2.02 | 105.19 | 95.00 | 1.50 | 1.00 | 97.50 |
| **1893.** |  |  |  |  |  |  |  |  |
| January | 95.00 | .......... | .......... | 95.00 | 95.00 | 2.50 | 1.10 | 98.60 |
| February | 95.00 | 6.00 | 3.05 | 104.05 | 95.00 | 48.90 | 1.00 | 144.90 |
| March | 95.00 | .......... | .......... | 95.00 | 95.00 | 3.50 | .......... | 98.50 |
| April | 95.00 | .......... | 2.33 | 97.33 | 95.00 | 3.00 | 2.33 | 100.33 |
| May | 223.50 | .......... | 2.40 | 225.90 | 223.50 | 1.50 | 2.40 | 227.40 |
| June | 136.67 | 5.00 | .......... | 141.67 | 136.67 | 3.00 | .......... | 139.67 |
| Total | 1,685.17 | 1,690.11 | 33.23 | 3,408.51 | 1,685.17 | 347.55 | 31.73 | 2,064.45 |

| Months. | Lock No. 5. |  |  |  | Lock No. 6. |  |  |  |
|---|---|---|---|---|---|---|---|---|
|  | Salaries. | Labor and materials. | Current and contingent expenses. | Total. | Salaries. | Labor and material. | Current and contingent expenses. | Total. |
| **1892.** |  |  |  |  |  |  |  |  |
| July | $264.63 | $118.01 | $2.23 | $384.87 | $186.66 | $114.72 | $2.23 | $303.61 |
| August | 153.33 | 285.00 | 6.29 | 444.62 | 103.83 | 40.75 | 6.30 | 150.88 |
| September | 203.34 | 159.95 | 5.10 | 368.39 | 203.34 | 101.96 | 5.00 | 310.30 |
| October | 153.33 | .......... | 2.33 | 155.66 | 117.33 | 3,351.41 | 2.33 | 3,471.07 |
| November | 153.33 | 4.35 | .......... | 157.68 | 108.33 | 1,286.24 | 7.65 | 1,402.22 |
| December | 95.00 | 15.00 | 2.02 | 112.02 | 95.00 | 25.05 | .......... | 120.05 |
| **1893.** |  |  |  |  |  |  |  |  |
| January | 95.00 | .......... | .......... | 95.00 | 95.00 | 3.35 | .......... | 98.35 |
| February | 95.00 | 3.00 | 3.06 | 101.06 | 95.00 | 4.14 | .......... | 99.14 |
| March | 95.00 | 46.58 | .......... | 141.58 | 95.00 | .......... | 1.60 | 96.60 |
| April | 95.00 | .......... | 2.33 | 97.33 | 95.00 | .......... | 2.33 | 97.33 |
| May | 223.51 | .......... | 2.40 | 225.91 | 223.51 | .......... | 2.40 | 225.91 |
| June | 136.66 | .......... | .......... | 136.66 | 136.66 | 7.45 | .......... | 144.11 |
| Total | 1,763.13 | 631.89 | 25.76 | 2,420.78 | 1,554.16 | 4,935.07 | 29.93 | 6,519.16 |

| Months. | U. S. snagboat Kentucky and steamer Fulton. |  |  |  | U. S. dredge Willie. |  |  |  |
|---|---|---|---|---|---|---|---|---|
|  | Salaries and labor | Repairs. | Supplies. | Total. | Salaries and labor. | Repairs. | Supplies. | Total. |
| **1892.** |  |  |  |  |  |  |  |  |
| July | $1,500.48 | $10.21 | $365.00 | $1,875.69 | $334.50 | $41.94 | .......... | $376.44 |
| August | 2,159.67 | 8.75 | 422.39 | 2,590.81 | 360.00 | .......... | $16.50 | 376.50 |
| September | 1,022.00 | 90.82 | 99.05 | 1,211.87 | .......... | .......... | .......... | .......... |
| October | 981.50 | 79.56 | 51.24 | 1,112.30 | 405.00 | .......... | .......... | 405.00 |
| November | 977.00 | .......... | 432.31 | 1,409.31 | 387.00 | .......... | 53.20 | 440.20 |
| December | .......... | 46.55 | 32.18 | 78.73 | .......... | .......... | .......... | .......... |
| **1893.** |  |  |  |  |  |  |  |  |
| January | .......... | .......... | 6.12 | 6.02 | .......... | .......... | .......... | .......... |
| February | .......... | .......... | 12.31 | 12.31 | .......... | .......... | .......... | .......... |
| March | .......... | .85 | 219.50 | 220.35 | .......... | .......... | .......... | .......... |
| April | .......... | .......... | 27.82 | 27.82 | 68.00 | .......... | .......... | 68.00 |
| June | 725.99 | .......... | 347.83 | 1,073.82 | 297.83 | 7.25 | 12.95 | 318.03 |
| Total | 7,366.64 | 236.74 | 2,015.75 | 9,619.13 | 1,852.33 | 49.19 | 82.65 | 1,984.17 |

*Detailed statement of expenses incurred in preserving and maintaining navigation on that portion of the Kentucky River, Kentucky, etc.*—Continued.

| | U. S. dredge Ward. | | | |
|---|---|---|---|---|
| | Salaries and labor. | Repairs. | Supplies. | Total. |
| 1892. | | | | |
| July | $405.00 | $83.45 | $49.70 | $538.15 |
| August | 250.00 | | 16.50 | 266.50 |
| September | 330.17 | | | 330.17 |
| October | 243.84 | | | 243.84 |
| November | 396.00 | | 59.68 | 455.68 |
| 1893. | | | | |
| January | 39.00 | | | 39.00 |
| April | | | 178.30 | 178.30 |
| Total | 1,664.01 | 83.45 | 304.18 | 2,051.64 |

SUMMARY.

| | |
|---|---|
| Lock No. 1, Kentucky River, Kentucky | $13,222.44 |
| Lock No. 2, Kentucky River, Kentucky | 2,432.20 |
| Lock No. 3, Kentucky River, Kentucky | 3,408.51 |
| Lock No. 4, Kentucky River, Kentucky | 2,064.45 |
| Lock No. 5, Kentucky River, Kentucky | 2,420.78 |
| Lock No. 6, Kentucky River, Kentucky | 6,519.16 |
| United States Snagboat Kentucky and steamer Fulton | 9.619.13 |
| United States dredge Willie | 1,985.17 |
| United States dredge Ward | 2,051.64 |
| Grand total | 43,723.48 |

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### REPORT OF FIRST LIEUT. H. E. WATERMAN, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
*Frankfort, Ky., June 30, 1893.*

MAJOR: I have the honor to submit the following report on the operating and care of canals and the maintaining and preserving of navigation on the Kentucky River for the fiscal year ending June 30, 1893:

Mr. R. S. Burnett, assistant engineer, was in local charge of the river to September 1, 1892, when relieved by Mr. I. V. Hoag, jr. The latter gentleman was relieved by me May 11, 1893.

A new line of boats has been established during the year between Frankfort and Louisville, Ky., called the People's Packet Company; Frank Myers, president; W. R. Jones, secretary; Sim Monday, treasurer.

The locks are in a fair condition with the exception of needing generally new lower gates. Several of the existing dams, however, will require extensive repairs in order to make them tight and secure. A considerable amount of dredging will also be necessary at the lock entrances.

The two most troublesome bridges on the river are the Louisville and Nashville Railroad Bridge and the highway bridge, both at Frankfort, Ky. In each case plans for the alteration of the bridges have been submitted to the Secretary of War, and have been approved by him. The adopted plan of the railroad bridge provides that the new bridge is to be 5 feet higher than the old in clear head-room. Work has been begun on the approaches to this bridge, but nothing is intended to be done on the channel span until some time in July, 1893.

In the case of the Highway Bridge, the adopted plan provides that the bridge shall be raised for a distance of 200 feet about 7 feet 4 inches, making its clear height the same as in the case of the Railroad Bridge. The 3 piers of the old bridge are to be removed to a depth of 7 feet below pool water. Advertisements were issued by the city for the building of this bridge, but all proposals were rejected on the ground of their being excessive. New bids were asked for, and were opened June 19, 1893. An expert on bridges has been employed by the city to investigate and report on the most feasible plan submitted.

The following is a detailed statement of the work done during the past fiscal year:

### LOCK NO. I.

*Crib extension below abutment.*—Excavated 297 cubic yards of clay and mud and 205 cubic yards of riprap from old crib for foundation of crib extension, and for foundation of anchor cribs 770 cubic yards of earth, clay, sand, and 80 cubic yards of riprap; drove with pile-driver 33 piles near river bank; laid in crib 9 pieces (2,352 feet B. M.) of old hewed timber and 710 pieces (209,640 feet B. M.) of new timber; laid in anchor cribs 54 pieces (9,588 feet B. M.) of old timber, and 108 pieces (26,904 feet B. M.) of new timber; placed in crib, as ballast, 2,817 cubic yards of riprap, and in anchor cribs 431 cubic yards; placed, as filling behind crib, 60 cords of logs and drift, 359 cords of brush, and 135 cubic yards riprap.

*Land crib above dam.*—Placed in landcrib above dam 150 cubic yards of riprap, and behind crib 112 cords of logs and drift and 49 cubic yards of riprap.

*Quarry at Gratz, Ky.*—Stripped from face of quarry 848 cubic yards of earth, clay, and spalls; quarried and broke into riprap 973 cubic yards; removed to river bank 1,210 cubic yards of riprap; loaded on barge, for shipment to lock No. 1, 171 cubic yards of riprap to be used as ballast in crib extension below abutment.

*Repairs to dam.*—Built cofferdam on abutment side of river to stop leak in dam; placed behind coffer 2 cords of brush and 1,167 cubic yards of sand, clay, and gravel; removed from apron on dam 17,526 feet B. M. of sheeting and stacked same on river bank; placed 595 cubic yards of riprap and 190 cubic yards of clay, sand, and gravel to stop leak; 190 cubic yards of clay and 25 cubic yards of riprap placed on apron of dam; spiked 56 pieces of sheeting on slope of dam, and 11 pieces of sheeting on lower step of dam near land crib.

*New upper lock gates.*—On account of convenience in building, it was decided to construct the new lock gates at Lock No. 3. Georgia long leaf yellow pine was purchased by circular letter, gates constructed, painted, new irons placed in position, gates launched on barge and towed to Lock No. 1. Old lock gates were removed, dismantled and new gates hung in position. Difficulty was found in making the gates miter, a cofferdam was constructed at the upper entrance, an examination made, and a poplar strip ¼-inch wide placed on the miter post of each gate. Iron plates for the ends of the gates have been made, but have not yet been placed in position.

*General repair work.*—Spiked on top of inside guard crib, 4 pieces of sheeting 3 by 12 inches by 20 feet for walk, and on upper guide crib 1 piece of sheeting 4 by 14 inches by 4½ feet. Spiked on upper guard crib 3 pieces sheeting 3 by 11 inches by 18 feet.

*Dredging.*—Dredge *Ward* dredged 250 cubic yards of sand, clay, and gravel from upper entrance, and 1,161 cubic yards from bar below dam, and placed same behind dam as backing.

*General work.*—Stacking and handling timber for crib extension; making wheelbarrow runs for placing riprap in cribs; transferring timber, tools, and materials from lock side to abutment side of river; handling loaded and empty barges and scows; coaling steam crafts; repairing tools and other property, cutting brush, hauling timber for new lock-gates from Worthville, Ky., to river bank, loaded same on barge and towed to Lock No. 3; dug ditch on lock side of river above slope wall.

*General remarks.*—Navigation was suspended on account of ice from January 7 to 30, and on account of high water 38 days during the year.

Highest water occurred February 21, upper gauge reading 34.40 feet, lower gauge 49.20 feet.

Lowest water occurred November 4, upper gauge reading 5 feet, lower gauge 4.10 feet.

### LOCK NO. 2.

*General work.*—Operating and care of lock and other Government property: removed 250 cubic yards of material in filling and grading around lock-keeper's dwelling; removed drift from upper entrance; scraped mud from behind lock gates; removed snow and ice from lock walls; destroyed vegetation in cribbing; replaced defective sheeting on dam; built cofferdam in lower entrance and placed new pintle on lock gate.

*Dredging.*—Dredge *Ward* removed from lower entrance, and from bar below dam 232 logs and 1,600 cubic yards of sand and gravel.

*General remarks.*—Navigation was suspended from January 6 to 30, on account of ice, nineteen days on account of high water, and two days repairing pintle.

Highest water occurred February 21, upper gauge reading 30.10 feet, lower gauge 41.60 feet.

Lowest water occurred November 13, upper gauge reading 6.50 feet, lower gauge 3 feet.

### LOCK NO. 3.

*New upper lock gates.*—Graded and leveled space for building gates; built skids; built tramway from lock to yard to handle gate timber; hauled timber from Worthville, Ky., to river bank; loaded on barge and towed to Lock No. 3; unloaded timber, dressed and fitted same, and built lock gates; painted gates and placed new irons in position; removed old gates and dismantled same; hung new gates in position.

*Upper guard crib.*—Removed 89 cubic yards of riprap from crib; faced and placed in position in wall 18 pieces of timber; laid 28 cross timbers; replaced riprap.

*Dredging.*—Dredge *Ward* dredged 800 cubic yards of material from lower entrance and 600 cubic yards from bar below entrance.

*General work.*—Operating and care of lock; removing drift from upper entrance; scraped mud from behind lock gates; removed snow and ice from lock walls; destroyed vegetation from slope wall and from cribbing; made ladder 16 feet long and fastened to cribbing on abutment side; set posts; dressed lumber and built fence 465 linear feet in front of lock houses.

*General remarks.*—Navigation was suspended on account of ice from January 6 to 29, and four days in February on account of high water.

Highest water occurred February 21, upper gauge reading 21.10 feet, lower gauge, 31.60 feet.

Lowest water occurred October 27, upper gauge reading 6.50 feet, lower gauge, 5.40 feet.

### LOCK NO. 4.

*General work.*—Operating and care of lock; built cofferdam in lower entrance; removed old and defective pintle from lower river gate and placed new pintle on same; removed two defective pieces of sheeting from dam and replaced with new; repaired fence around Government property; repaired basement in lock-keeper's dwelling; repaired tool house; removed drift from lock entrance; scraped mud from behind lock-gates; removed ice and snow from lock walls; destroyed vegetation from slope wall and from cribbing.

*Dredging.*—Dredge *Willie* removed from upper entrance 64 logs and 960 cubic yards of material; from the lock pit 310 cubic yards and from lower entrance 645 yards; total, 1,915 cubic yards.

*General remarks.*—Navigation was suspended December 30 and from January 9 to 29 on account of ice, and four days in February on account of high water.

Highest water occurred February 21, upper gauge reading 18.50 feet, lower gauge reading, 32.40 feet.

Lowest water occurred October 21; upper gauge reading, 5.20 feet; lower gauge, 4.80 feet.

### LOCK NO. 5.

*General work.*—Operating and care of lock. Cemented slope wall; dug ditch 50 feet long and 5 feet deep, from assistant lock-keeper's dwelling to river bank; repaired broken wicket; placed 50 cubic yards of riprap above dam to stop lead; placed behind dam as backing, 694 cubic yards of clay and gravel; removed 25 pieces of defective sheeting from steps of dam, and 15 pieces of slope sheeting and replaced same with new sheeting; scraped mud from behind lock gates; removed drift from upper entrance; removed snow and ice from lock walls. Dredged at Lock No. 6, by the dredges *Willie* and *Ward*, 3,750 cubic yards of gravel, loaded on barges towed to lock No. 5 and placed behind dam as backing.

*Dredging.*—It was not found necessary to dredge lock entrances during the year.

*General remarks.*—Navigation was suspended from January 7 to 30, on account of ice, and two days in February on account of high water.

Highest water occurred February 20, upper gauge reading 20.50 feet, lower gauge 31.10 feet.

Lowest water occurred October 18, upper gauge 4.60 feet, lower gauge 5.30.

### LOCK NO. 6.

After the high water of last year it was found that much of the step sheeting had been knocked off, and that the riprap filling had washed out. This rock ballast was found entirely gone under the first step for a distance of 66 feet adjoining the abutment, also for a distance of 59 feet, beginning 36 feet away from the lock wall. In the second step it was all gone for a distance of 58 feet from the abutment, and in the third step about two-thirds gone for 27-feet from the same point.

This damage was caused by the return wave from below, which it was decided to counteract by a re-inforcing apron. Before this was completed the work was stopped by high water. As the new cribs were not properly tied to the old work, two of them have apparently been washed out, leaving only one in place. It is now proposed to complete this apron all the way across and to tie it frequently to the dam proper, raising it to the level of the lower step.

*Dam.*—Removed 62 linear feet of sheeting from steps of dam in order to fill same with ballast. Placed in steps next to abutment 721 cubic yards of riprap; placed in steps in middle of dam 35 cubic yards, and in step next to lock 132 cubic yards of riprap. Total amount of riprap placed in steps of dam, 888 cubic yards. Placed 8,287 cubic yards of clay, sand, and gravel behind dam as backing. Replaced 62 linear feet of sheeting on steps of dam.

*Abutment.*—Placed at base of abutment, between end of reinforcing crib and ledge of stone on river bank, 9 cubic yards, 12 cubic feet of concrete. Placed below concrete two pieces of cut stone (24 cubic feet) and fastened them together with iron clamps.

*Reinforcing cribs.*—Reinforcing cribs were built as follows:

Crib No. 1: Extending 112 feet from the abutment side, 16 feet wide and about 12 feet deep.

Crib No. 2: Extending 92 feet from the lock wall, 16 feet wide and 14 feet deep.

Crib No. 3: Extending from Crib No. 2 towards Crib No. 1, 112 feet 16 feet wide and 14 feet deep.

Crib No. 4: The framing of this crib, 96 feet long, 16 feet wide, and 14 feet deep, was begun but high water prevented its completion.

*Total amount of material used.*

| | Timber. | | | | | |
|---|---|---|---|---|---|---|
| | Pieces. | Linear feet. | Feet B. M. | Spikes. | | |
| | | | | ⅝ by 12 inches. | ¾ by 16 inches. | ¾ by 24 inches. |
| Crib No. 1 | 370 | 7,612 | 42,851 | 81 | 698 | 212 |
| Crib No. 2 | 231 | 3,950 | 28,700 | .......... | 611 | 244 |
| Crib No. 3 | 418 | 7,542 | 53,677 | .......... | 788 | 588 |
| Total | 1,019 | 19,104 | 125,228 | 81 | 2,097 | 1,044 |

*Lock.*—Cut grooves in both walls of the tail-bay to hold cross timbers of cofferdam; rounded corners of ladder ways to low water; placed new bedplate in lock-wall to hold wicket screen; placed new wicket screens in culverts of both walls; removed yoke or boxing from bracket of auxiliary dam in fore bay; repaired same by cutting off the top of the boxing and substituting an iron strap across same; rounded ladder ways in both walls.

*General work.*—Operating and care of lock; watching and caring for barges, scows, and other Government property and materials; painted lock-gates; receiving and framing timbers for cribs; rigging derricks for handling timbers; receiving and handling riprap; quarrying riprap; hauling fuel and pumping water for hoisting engines; repaired and calked barges and scows; quarried 48 cubic yards of riprap for Lock No. 2; caring for tools and materials; general carpenter and blacksmith work; sharpening and repairing tools.

*General remarks.*—Navigation was suspended from January 9 to 29 on account of ice.

Highest water occurred February 20; upper gauge reading 20.00 feet, lower gauge 27.20 feet.

Lowest water occurred November 8; upper gauge 4.50 feet, lower gauge 3.00 feet.

### STEAMER L. A. FULTON.

The steamer *L. A. Fulton* was chartered July 6 to August 11, 1892, to take the place of the United States snag-boat *Kentucky*.

Started from Louisville, Ky., to Parkersburg, W. Va., on July 7, after the dredge *Willie;* returned to the Kentucky River July 16 and took dredge to Lock No. 6 on the 18th; acted as tender to dredges *Ward* and *Willie;* towed barges of clay, sand, and gravel from Lock No. 6 to Lock No. 5, and placed same behind dam as backing; towed dredge *Ward* and two dump scows to Lock No. 3; towed the two Ohio River dump scows to Cincinnati, Ohio, August 6, 1892.

### UNITED STATES SNAG BOAT KENTUCKY.

The United States snagboat *Kentucky* has been engaged in towing dredges, barges, and scows at the several locks; assisted in building cofferdam on the abutment side at Lock No. 1 to repair dam; built cofferdam in upper entrance to Lock No. 1, and made examination of lock-gates, and placed a poplar strip seven-eighths of an inch on the miter post of each gate; built cofferdam in lower entrance at Lock No. 2 and placed pintle on gate; built cofferdam at Lock No. 4 in lower entrance; removed old and defective pintle and placed new pintle in position; towed dredge *Ward* to the Big Sandy River February 10, 1893; removed 122 snags during the year, and run 6,110 miles.

### UNITED STATES DREDGE WARD.

The United States dredge *Ward* dredged 2,475 cubic yards of clay, sand, and gravel at Lock No. 6 for backing Dam No. 5; 650 cubic yards of sand and gravel dredged and placed behind Lock No. 6 as backing; towed to Lock No. 3 and dredged from lower entrance 800 cubic yards of sand and gravel, and from bar below lock 600 cubic yards; assisted in changing the irons for the new lock-gates; towed to Lock No. 1, dredged 1,061 cubic yards of sand and gravel from below dam, and placed same above dam as backing; assisted in building cofferdam, dredged 100 cubic yards of material for backing same; removed cofferdam from upper entrance; removed 232 logs and 1,600 cubic yards of material from entrances at Lock No. 2; assisted in building cofferdam at Lock No. 4, and removed same; made necessary repairs to machinery and built cabin on boiler deck; towed to the Big Sandy River by the snag boat *Kentucky* February 10, 1893.

### UNITED STATES DREDGE WILLIE.

The United States dredge *Willie* was towed to Lock No. 4 June 20; removed from upper entrance to lock 64 logs and 960 cubic yards of material; from the lock-pit 310 cubic yards, and from the lower entrance 645 cubic yards of sand and mud. Total amount of material removed, 1,915 cubic yards. Towed to Lock No. 3, and dredged 1,450 cubic yards of material from lock entrances.

Dredged at Lock No. 6 1,275 cubic yards of clay, sand, and gravel for backing Lock No. 5, and 500 cubic yards for backing No. 6.

### UNITED STATES DERRICK BOAT.

The United States derrick boat assisted in building the crib extension of dam below abutment at Lock No. 1, handling and stacking timbers, handling riprap and other material; towed to Lock No. 6 December 8, 1892; used in handling timber, etc., at Lock No. 6; painted boat and repaired machinery.

Respectfully submitted,

H. E. WATERMAN,
*First Lieutenant of Engineers.*

Maj. D. W. LOCKWOOD,
*Corps of Engineers, U. S. A.*

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*Commercial statistics of Kentucky River, Kentucky, for fiscal year ending June 30, 1893.*

| Articles. | 1890. | 1891. | 1892. | 1893. |
|---|---|---|---|---|
| | *Tons.* | *Tons.* | *Tons.* | *Tons.* |
| Beer | ........ | ........ | 345 | 325 |
| Brick | ........ | ........ | 130 | 771 |
| Coal | 89,562 | 89,752 | 203,224 | 176,871 |
| Cement | ........ | ........ | 200 | 212 |
| Cooperage | ........ | ........ | 736 | 1,116 |
| Cross-ties | ........ | ........ | 1,445 | 889 |
| Grain | 6,991 | 14,279 | 10,219 | 725 |
| Flour | 1,503 | 1,744 | 6,233 | 12,094 |
| Hay | 4,407 | 500 | 6,486 | 5,120 |
| Iron | 1,903 | 712 | 4,292 | 5,671 |
| Live stock | 2,350 | 3,065 | 2,506 | 493 |
| Logs | 158,903 | 224,844 | 72,749 | 2,071 |
| Lumber | 10,670 | 15,256 | 13,336 | 63,197 |
| Merchandise, miscellaneous | 19,554 | 21,739 | 60,618 | 28,156 |
| Salt | 909 | 1,602 | 9,025 | 4,276 |
| Timber | 4,682 | 3,761 | 21,831 | 3,131 |
| Tobacco | 2,783 | 5,636 | 11,199 | 5,808 |
| Whisky | 4,142 | 4,306 | 4,098 | 3,263 |
| Passengers | 1,995 | 2,023 | 3,172 | 3,176 |
| Total | 310,354 | 389,219 | 431,846 | 330,449 |

*List of stern-wheel boats plying on the Lower Kentucky River, Kentucky.*

| Name of boat. | Character. | Length. | Breadth. | Depth. | Tonnage. |
|---|---|---|---|---|---|
| | | *Feet.* | *Feet.* | *Feet.* | |
| Kentucky | United States snag boat. | 136.6 | 30 | 4.6 | 330 |
| Jennie Campbell | Packet | 144 | 26.5 | 4 | 225.06 |
| Falls City | do | 132.5 | 27 | 4.4 | 223.35 |
| Bellaire | do | 127.3 | 24.2 | 3.6 | 116.77 |
| City of Clarksville | do | 126 | 26 | 3.6 | 194 |
| John Barrett | do | 124.8 | 31 | 5.5 | 187.28 |
| Transit | do | 124 | 24 | 3.6 | 88 |
| Rescue | do | 121 | 28 | 4 | 139.03 |
| Sea Lion | do | 121 | 20.8 | 3.1 | 106.33 |
| S. R. Van Meter | do | 112 | 18.3 | 3.4 | 96.56 |
| Ida Smith | do | 111.6 | 17.9 | 2.6 | 44.14 |
| Isere | do | 101.3 | 20.4 | 3.7 | 63.97 |
| Little Sandy | do | 94 | 16 | 3 | 39.34 |
| J. F. O'Connell | do | 92.6 | 18.1 | 3.4 | 54.74 |
| Kate Prather* | do | 93 | 14 | 3 | 49.79 |
| Ada V.* | do | 92 | 13.6 | 2.2 | 21.32 |
| Ghent† | do | 53 | 10 | 4 | 4.85 |
| Excell | Towboat | 122 | 21.5 | 3.5 | 118.90 |
| L. A. Fulton | do | 122 | 22 | 3 | 107.99 |
| Comet | do | 114 | 23 | 3.9 | 100.08 |
| Hot Spur | do | 110 | 22 | 3 | 89.39 |
| Al Martin | do | 112 | 23.6 | 4 | 96.68 |
| Bessie Siler | do | 93 | 16 | 3 | 49 |
| Tom Ross | do | 33 | 6.6 | 3.6 | 9.72 |
| D. D. Baker | Sawmill | 177 | 18.3 | 4.3 | 70.83 |
| Sawyer | do | 116 | 18 | 4.2 | 70 |
| W. L. Norton | Packet | 76 | 12 | 1.6 | 43.60 |
| Inez | Towboat | 21 | 6 | 3.6 | 1.50 |

* Side-wheeler. † Screw propeller.

*Report of lockages on Kentucky River, Kentucky, for fiscal year ending June 30, 1893.*

| Locks. | Days operated. | Days suspended. | Going up. | | | Going down. | | | | Total craft and flats passing. | Total number lockages. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Steamboats. | Barges and flats. | Miscellaneous. | Steamboats. | Barges and flats. | Rafts. | Miscellaneous. | | |
| No. 1 | 303 | 62 | 440 | 205 | 30 | 435 | 196 | 149 | 26 | 1,481 | 1,065 |
| No. 2 | 319 | 46 | 405 | 140 | 67 | 406 | 146 | 149 | 74 | 1,387 | 1,273 |
| No. 3 | 337 | 28 | 260 | 138 | 65 | 263 | 146 | 126 | 60 | 1,058 | 960 |
| No. 4 | 340 | 25 | 268 | 139 | 140 | 268 | 142 | 144 | 164 | 1,265 | 1,117 |
| No. 5 | 339 | 26 | 172 | 77 | 125 | 169 | 78 | 1,010 | 111 | 1,742 | 1,281 |
| No. 6 | 344 | 21 | 90 | 118 | 328 | 91 | 121 | 1,111 | 339 | 2,198 | 1,266 |
| Total | ...... | ...... | 1,635 | 817 | 755 | 1,632 | 829 | 2,689 | 774 | 9,131 | 6,962 |

## I I 8.

## IMPROVEMENT OF LICKING RIVER, KENTUCKY, BETWEEN FARMERS AND WEST LIBERTY.

The project for the improvement of this river was approved by the Secretary of War under date of September 20, 1888, and provides for the removal of snags, detached rocks, and bowlders, with a view to improving low-water navigation and rafting.

During past years the stretch of river between Farmers and West Liberty, 68 miles in extent, has been improved each year that appropriations have been made, so far as the amount of money available would permit, the object being to enable light-draft boats to use the river at a lower stage than was formerly possible and to facilitate rafting.

The original estimate of the cost of this improvement was $17,680, and it is recommended that of the balance yet unappropriated $5,000 be appropriated for the fiscal year ending June 30, 1895.

The river, under the present project, is not susceptible of permanent improvement for the reason that such obstructions as snags, leaning trees, stumps, etc., are liable to occur after each high water.

### APPROPRIATIONS.

| | |
|---|---|
| August 11, 1888 | $3,000 |
| September 19, 1890 | 3,000 |
| Total | 6,000 |

### *Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $207.44 |
| June 30, 1893, amount expended during fiscal year | 207.44 |
| Amount (estimated) required for completion of existing project | 11,680.00 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895 | 5,000.00 |
| Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893. | |

NOTE.—It has been impossible to obtain commercial statistics.

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## I I 9.

## IMPROVEMENT OF BIG SANDY RIVER, WEST VIRGINIA AND KENTUCKY.

The Big Sandy River, which is formed by the union of the Tug and Levisa forks, flows north a distance of 26 miles and empties into the Ohio at Catlettsburg, Ky. The main river and the Tug form the boundary between Kentucky and West Virginia, and the Upper Tug, for a distance of about 18 miles, forms the boundary between Virginia and West Virginia. The Tug Fork rises in the southwest corner of West Virginia and flows northwest to its junction with the Levisa Fork, with a total length of 140 miles. The Levisa Fork rises in the southwestern part of Virginia, then entering Kentucky flows in a northerly direction. Its total length is about 189 miles.

The original project for improvement was adopted in 1878. and provided for the removal of obstructions from the Big Sandy and its two forks in order to facilitate push-boat navigation and rafting.

In 1880 this project was modified with a view to securing slack-water navigation by a system of locks and dams, and the first lock and dam were located at Louisa, Ky., just below the junction of the two forks, for the reason that the pools formed in the forks could be used for storage purposes during low water, and thus afford advantages for mining coal that no other location for a single lock could give.

The original project provided for a fixed dam, and at the end of the season 1890 the lock, with its fittings and the abutments, as well as about 80 feet of the dam, had been constructed.

The timber and shipping interests of the river having made objections to a fixed dam, under date of May 20, 1891, a board of engineer officers was constituted "to consider and report upon the subject of the dam to be built in the Big Sandy River."

In its final report this board recommended the substitution of a needle dam for the fixed dam, the clear height of the pool formed by it to be 13 feet above the sill of the navigable pass.

Under date of March 1, 1893, I had the honor to submit a partial report on movable dam proposed for this river, with maps showing the general features of the work. These were approved under date of March 6, 1893.

The approved plan calls for a navigable pass 130 feet long, and a weir 140 feet long, separated from the pass by a pier.

The elevation of the sill of the pass is placed at the extreme low-water mark at the time the lock was built, thus placing it 9 inches above the lower miter sill of the lock..

During the past year the lock walls have been lowered 7 feet, the upper miter sill has been cut down so that the top of the upper miter sill will be on an elevation of 2 feet above the lower miter sill. The old lower gates have been cut down to suit the changed conditions, the upper and lower entrances to the lock have been deepened to the proper depth, and a cofferdam constructed to inclose the site of the pass and pier. Contracts have been let for the iron work that will be built into the masonry of the pass and pier, and nearly all the cut stone required for the pass and pier is ready to be laid in the foundation. It is hoped to complete the masonry of the pass and weir during the present season.

It is more than likely that when all the details of the plans have been completed a slight change will be required in the estimate, somewhat increasing the amount.

APPROPRIATIONS.

| | | | |
|---|---|---|---|
| July 18, 1878 | $12,000 | August 5, 1886 | $22,500 |
| March 3, 1879 | 12,000 | August 11, 1888 | 31,500 |
| June 14, 1880 | 50,000 | September 19, 1890 | 31,000 |
| March 3, 1881 | 46,000 | July 13, 1892 | 50,000 |
| August 2, 1882 | 15,000 | | |
| July 5, 1884 | 40,000 | Total | 310,000 |

*Money statement.*

| | | |
|---|---|---|
| July 1, 1892, balance unexpended | | $16,107.87 |
| Amount appropriated by act approved July 13, 1892 | | 50,000.00 |
| | | 66,107.87 |
| June 30, 1893, amount expended during fiscal year | | 37,960.41 |
| July 1, 1893, balance unexpended | | 28,147.46 |
| July 1, 1893, outstanding liabilities | $4,944.91 | |
| July 1, 1893, amount covered by uncompleted contracts | 2,964.50 | |
| | | 7,909.41 |
| July 1, 1893, balance available | | 20,238.05 |
| Amount (estimated) required for completion of existing project | | 28,029.25 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895 | | 28,029.25 |

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

*Abstract of proposals received and opened June 10, 1893, by Maj. D. W. Lockwood, Corps of Engineers, for furnishing wrought and cast-iron work for improving Big Sandy River, West Virginia and Kentucky.*

| No. | Name and address of bidder. | Cast iron, 61,000 pounds. (per pound). | Wrought iron, 33,000 pounds. (per pound). | Total. |
|---|---|---|---|---|
| | | *Cents.* | *Cents.* | |
| 1 | The Hoefinghoff & Laue Foundry Co., Cincinnati, Ohio | $03\frac{2}{10}$ | $05\frac{3}{10}$ | $3,701.00 |
| 2 | Patton, Hall & Patton, Marietta, Ohio | $05\frac{18}{100}$ | $07\frac{1}{2}$ | 5,634.50 |
| 3 | Charles Barnes, Cincinnati, Ohio | 03 | 06 | 3,810.00 |
| 4 | Lambert Bros. & Co., Ironton, Ohio | $04\frac{55}{100}$ | $05\frac{55}{100}$ | 4,607.00 |
| 5 | The I. & E. Greenwald Co., Cincinnati, Ohio | $04\frac{1}{2}$ | 06 | 4,725.00 |
| 6 | The Francis Futsch Foundry and Machine Co., Cincinnati, Ohio | 03 | $06\frac{3}{4}$ | 4,057.50 |
| 7 | George Kinsey & Co., Cincinnati, Ohio | $02\frac{3}{4}$ | $03\frac{9}{10}$ | 2,964.50 |

Contract awarded George Kinsey & Co.

## REPORT OF MR. B. F. THOMAS, ASSISTANT ENGINEER.

LOUISA, KY., *June 30, 1893.*

MAJOR: As there was no money available sooner, work was not begun upon Big Sandy River until the middle of August last season.

A great amount of deposit had formed in the approaches above and below the lock, and this was removed, and the ledge of rock forming an obstruction to the entrances to the lock was blasted out. The material taken out was used for riprapping the river banks above and below the lock, which had washed badly. A crib extending about 400 feet above, and about the same distance below the lock, was put in to catch the toe of the riprap. This crib was bolted to the top of the ledge of rock, and is about 4 feet in height. A good part of the rock blasted was removed to the opposite side of the river and utilized in protecting the banks there. Much of it was wasted in the river and has since been removed by the dredge.

In the original construction of the lock, the walls were built so as to have a 10-foot guard above the dam, but as the change of plan from a stationary to a movable dam reduces the height of the dam some 5 feet, it was thought advisable to also reduce the height of the lock walls—the more so as the new dam will require considerably more masonry, and this reduction of the walls will supply the required stone.

As a movable dam is down during high water, there is no necessity for a high guard anyhow; so the walls were reduced 7 feet. The stones removed from the land wall were piled in the yard, as were those from the head wall and miter wall, while those from the river wall were repiled on the wall itself after the coping was relaid. The upper miter sill was cut down to an elevation of 2 feet above the lower sill, and the lower gates were reduced in height to correspond with the walls.

The upper gates were removed and have not yet been replaced.

The river bank opposite and below the lock was well protected with a heavy layer of broken stone taken from the dump lying outside the lock, the rock being transported across the river on dump cars.

The walls having been cut down and the coping reset, and the excavation of the approaches to the lock having been completed, work was closed for the season in December, and was not resumed until early in March, when the United States dredge *Ward* arrived here.

The dump of waste material lying outside of and above and below the lock, and being about 1,000 feet long, has been pretty well removed by the dredge, the material having been carried away by barges and wasted along the river banks below. The dredge has also excavated for the first section of cofferdam, and partially backed the coffer up outside. The stone for concrete for pass has all been broken and about half that for the weir. The stone was gotten from the upper lock approach for the pass concrete, and from the waste dump for the weir, and is hard and durable.

The cutting of stone for the movable dam was begun about the 1st of April and has been carried on with a good force ever since. The stone for pass and pier have all been cut, leaving those of the weir yet to get ready. The stone used are those removed from the lock walls, and those left over in the construction of the lock.

As is the case on work of this class, there has been a great amount of miscellaneous work done, such as repairs to tools and machinery, moving machinery from one part of the works to another, the laying of tracks, the construction of trestle work, the erection of derricks, building cars, sheds, pile-drivers, etc.

Owing to the continued high water this season the cofferdam for pass was not commenced until the 1st of June, and the work has been stopped once since by high water.

The timber originally purchased for the stationary dam has been used in the coffer, so far as it would answer the purpose, and a contract was made with W. C. Bartram for about 50,000 feet additional, which has been delivered. The clay for filling the coffer could not be found at a convenient point for dredging, so it was taken from the Kentucky bank, where some grading was necessary anyway, and conveyed in wheelbarrows across the river.

The dam, as last located, is to be near the lower end of lock, and this will necessitate the removal of the abutment; the work of tearing it down has already begun.

An assignment has been made with Jay H. Northup, of Louisa, for furnishing the timber for the pass sills, but the delivery has not yet been completed.

*Summary of work done.*

| Excavation: | Cubic yards. |
|---|---|
| Approaches to lock: | |
| Earth | 15,000 |
| Loose rock | 4,050 |
| Solid rock | 7,920 |
| By dredge, sand, rock, etc | 37,832 |
| For coffer: Clay, etc | 1,125 |

Number feet holes drilled for rock excavation, 9,869; broken stone put in cribs for protection of banks, 4,800 cubic yards; broken stone used for riprap, 7,170 cubic yards; coal mined, 7,000 bushels; masonry removed, 1,701.98 cubic yards; masonry reset, 395.27 cubic yards; stone cut, 585.95 cubic yards; concrete stone broken, 802 cubic yards.

To sum up, then, the close of the year finds the following work yet to be done: The construction of the foundation and superstructure of the entire movable dam; the rebuilding of the upper lock gates; the paving of the banks adjoining lock and abutment; the protection of the bank below abutment by crib work; the straightening of the ledge of rock in the approaches to the lock, and putting fenders therein; the construction of a guide crib above the lock; the completion of the dredging already begun, of material lying in the chute, and above low-water mark; the removal of the abutment.

Respectfully submitted.

B. F. THOMAS,
*Assistant Engineer.*

Maj. D. W. LOCKWOOD,
*Corps of Engineers, U. S. A.*

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COMMERCIAL STATISTICS.

*Commerce of Big Sandy River, West Virginia and Kentucky, for fiscal year ending June 30, 1893.*

| Articles. | 1890. | 1891. | 1892. | 1893. |
|---|---|---|---|---|
| | *Tons.* | *Tons.* | *Tons.* | *Tons.* |
| Hides | 75 | 50 | 40 | 35 |
| Leather | 34 | 30 | 4 | 6 |
| Lumber | 3,000 | 3,000 | 60 | 650 |
| Produce | 2,511 | 3,000 | 250 | 1,755 |
| Live stock | 495 | 500 | 150 | 1,190 |
| Spokes | 750 | 2,200 | 4,080 | 530 |
| Staves | 7,000 | 1,050 | 5,260 | 1,803 |
| Tan bark | 9,831 | 10,000 | 28,950 | 1,950 |
| Timber, logs, and knots | 208,491 | 225,000 | 300,050 | 331,570 |
| Ties, railroad | 15,000 | 10,000 | 99,625 | 68,750 |
| Wheat | 510 | 489 | .......... | .......... |
| Wool | 11 | 15 | 7 | 7 |
| Miscellaneous | 19,000 | 21,069 | 16,050 | 55,914 |
| Passengers | 1,874 | 900 | 1,400 | 2,563 |
| **Total** | 268,582 | 277,308 | 455,926 | 466,723 |

*List of boats plying on Big Sandy River, West Virginia and Kentucky.*

| Name of boat. | Length. | Breadth. | Depth. | Tonnage. |
|---|---|---|---|---|
| | *Feet.* | *Feet.* | *Feet.* | |
| Andy Hatcher (stern-wheel) | 117 | 18 | 3 | 65 |
| Beulah Brown (side-wheel) | 118 | 15 | 2.5 | 37.71 |
| Fairplay (side-wheel) | 125 | 19 | 3 | 49 |
| Favorite (side-wheel) | 103 | 14.8 | 2.5 | 43.64 |
| Frank Preston (stern-wheel) | 110 | 18 | 3 | 60 |
| J. C. Hopkins (side-wheel) | 102.5 | 16.4 | 2.4 | 67 |
| Jennie George (side-wheel) * | 90 | 14 | 2 | 19.05 |
| Lexington (stern-wheel) | 120 | 22 | 3.5 | 48.72 |
| Mary L. Hatcher (stern-wheel) | 110.4 | 20 | 3 | 55.05 |
| Sandy Valley (side-wheel) | 105 | 14 | 2.8 | 40 |
| Sip Bayes (side-wheel) | 100 | 14 | 1.8 | 24.12 |
| Buckeye Boy (tow, stern-wheel) | ........ | ........ | ........ | ........ |
| Gate City (tow, stern-wheel) | ........ | ........ | ........ | ........ |
| Sea Lion (tow, stern-wheel) | ........ | ........ | ........ | ........ |
| Tom Spurlock (tow, stern-wheel) | 117 | 22 | 3 | 100 |

* New line.

## I I 10.

## IMPROVEMENT OF LEVISA FORK OF BIG SANDY RIVER, KENTUCKY.

The Levisa is the western of the two forks that unite at Louisa to form the Big Sandy River. It rises in the southwestern part of Virginia, at an elevation of about 1,500 feet above tide water, and flows in a northerly direction. Its banks in many cases are rocky, in others composed of sand and clay. It possesses all the characteristics of a mountain stream, a steep average slope, and pools of varying depth, separated by rock bar or ripples that at low water often have but a few inches of water over them. The average fall from Pikeville to Louisa is 1.49 feet per mile, the distance being 86½ miles.

The object of the improvement has been to facilitate rafting and push-boat navigation in the upper river and to improve low-water steamboat navigation so far as this can be done. Steamboats can not run in this or Tug Fork at dead low water, but the work done so far has been of such character as to permit of their running on smaller rises than was the case before the improvement was commenced. Coal mines have been opened at and near Peach Orchard, and quite extensive shipments are made by rail to Ashland, on the Ohio, where it is put in barges for transportation down that river. Could coal be shipped out by water from the mines the output of coal would be largely increased.

The work of previous years has removed the most important obstructions, so that during the past season it was only necessary to clear out chutes that had become obstructed by material washed in during the preceding high waters, and take out such obstructions as logs, stumps, and snags that are always found in the channel after a rise.

The stream under the present project is incapable of permanent improvement, as the obstructions to navigation, such as snags, stumps, logs, etc,, are liable to reform at any time, and an annual appropriation of about $2,500 is needed to keep it clear.

For details of work done during the past year attention is respectfully invited to the report of Assistant Engineer B. F. Thomas, appended hereto.

## APPROPRIATIONS.

| | |
|---|---|
| June 14, 1880 | $2,500 |
| March 3, 1881 | 2,000 |
| August 2, 1882 | 5,000 |
| July 5, 1885 | 5,000 |
| August 5, 1886 | 3,750 |
| September 19, 1890 | $2,500 |
| July 13, 1892 | 2,500 |
| Total | 23,250 |

### *Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $19.86 |
| Amount appropriated by act approved July 13, 1892 | 2,500.00 |
| | 2,519.86 |
| June 30, 1893, amount expended during fiscal year | 1,645.96 |
| July 1, 1893, balance unexpended | 873.90 |
| July 1, 1893, outstanding liabilities | 301.08 |
| July 1, 1893, balance available | 572.82 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895 | 2,500.00 |

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

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#### REPORT OF MR. B. F. THOMAS, ASSISTANT ENGINEER.

LOUISA, KY., *June 30, 1893.*

MAJOR: About the middle of last August a crew of 14 men with 2 push-boats was sent out on Levisa Fork and removed obstructions at Capertons, Millers, McClures, Contrary Creek, Georges Creek, Richardson, Graves Shoal, Fannins, Big White House Shoal, Red House, Wild Goose, Greasy, Little Fish-trap, Vince Prestons, Mill Branch, Buffalo Shoal, Muddy Branch, Mill Shoal, Hells Gate, Draw Bars, Porter Ripple, Burks, Hagers, Wiremans, Moody Georges, Abbotts, Prestonsburg, Brandy Keg, Dry Shoal, Garrett Shoal, Sugar-loaf, Lestlie Shoal, Haws Ford, the Prater Shoals, Davidson, Ivy, Laynes Mill, Loars Landing, Grimes Shoal, Stone Coal, and Long Shoal. The work consisted, generally, of the removal of rocks, trees, logs and stumps from the shoals and chutes, as well as the rebuilding of some of the wing-walls. Owing to the fact that the water got too low for even the smaller craft, the work was closed much earlier than it otherwise would have been. It was resumed again during the present month, and after removing some large rocks from Greasy and Buffalo Shoals, and doing some work of minor importance at a few other places, the boats were pushed on to the upper part of the river where there is some work to do that is much needed.

A summary of the year's work is as follows:

| | | |
|---|---|---|
| Solid rock removed | Cubic yards | 274 |
| Loose rock removed | do | 2,030 |
| Snags removed | | 304 |
| Trees removed | | 48 |
| Stumps removed | | 214 |

Respectfully submitted.

B. F. THOMAS,
*Assistant Engineer.*

Maj. D. W. LOCKWOOD,
*Corps of Engineers, U. S. A.*

NOTE.—Commercial statistics included in the report for improving Big Sandy River, West Virginia and Kentucky.

## I I II.

## MPROVEMENT OF TUG FORK OF BIG SANDY RIVER, WEST VIRGINIA AND KENTUCKY.

The Tug Fork is the eastern of the two forks which unite at the own of Louisa, 26 miles from the Ohio to form the Big Sandy River. t rises in the southwest corner of West Virginia and flows towards he northwest for a distance of 140 miles. For a distance of 18 miles at its head it forms a part of the boundary between Virginia and West Virginia, and below this it and the Big Sandy form the boundary between West Virginia and Kentucky.

The Tug throughout most of its length is a characteristic mountain stream formed of a series of pools separated by ripples.

The average fall per mile from Pond to Warfield, a distance of 23.5 miles, is 1.96 feet per mile, and from Warfield to Louisa, a distance of 35 miles, 1.72 feet per mile.

The object of the improvement has been to facilitate rafting of logs from the upper portion of the stream and its branches, to provide a low-water push-boat channel, and to make it possible for light-draft steamboats to run at lower stages than formerly while the river was in an unimproved state.

The work done has been that of clearing the channel of rocks, snags, stumps, etc., and the banks of overhanging trees, while with special reference to the push-boat interests, channels have been cut through the ripples or shoals.

The Government has improved this river from its mouth at Louisa, to Baileys Dam, a distance of 100 miles.

As the roads through the mountains are little more than trails, they are entirely unfitted for freighting purposes, so that the people along the river, and particularly those well up the stream, are almost entirely dependent upon water transportation for obtaining supplies, etc. The lower portions of the river are reached by steamboats, but above steamboat navigation push-boats alone can be used, and little channels have been made through the shoals and ripples in the past for their passage.

This kind of navigation may appear to be of comparatively little account, but gains in importance materially when it is considered that it furnishes the only means of communication for obtaining supplies.

Again, the Tug being a small stream of steep slope with rocky banks in many places, it is dangerous to run rafts in high rises, owing to the difficulties of management due to sharp bends and swift currents; consequently, timber is brought out only on moderate rises and, preferably, on a falling river.

The Norfolk and Western Railroad follows the right bank of the river for some distance, and its construction has, to a greater or less extent, affected the navigable capacity of 22 miles of the river from the upper limit of the improved portion down. In clearing the right of way and grading, stumps and trees were rolled into the river, and large quantities of rock were blasted into the stream. It is claimed by the railroad people that these obstructions have been removed, and that the river is in good condition again; river men deny this, and an inspection, when the river gets sufficiently low, will alone determine the situation.

Under date of July 1, 1891, the Norfolk and Western Railroad *et al.* were perpetually enjoined from obstructing the navigation of the Tug Fork, and ordered to remove obstructions already created by them before the 15th day of November, 1891; and, furthermore, they were permitted to go forward with the construction of the road, and if any rocks, trees, etc., were accidentally or from necessity thrown into the stream they were to be removed within three months; and, finally, all said rock, stone, trees, logs, lumber, timber, and débris were to be removed before November 15, 1892. A bond of $25,000 was required for faithful compliance with the decree.

The report of Assistant Engineer Thomas, appended hereto, gives details of work done during the past fiscal year.

It may be stated that the improvement of this stream is not permanent in its character, as the obstructions, such as snags, sunken logs, etc., are liable to re-form each year.

### APPROPRIATIONS.

| | | | |
|---|---|---|---|
| June 14, 1880 | $2,500 | September 19, 1890 | $2,500 |
| March 3, 1881 | 2,000 | July 13, 1892 | 2,500 |
| August 2, 1882 | 5,000 | | |
| July 5, 1884 | 5,000 | Total | 23,250 |
| August 5, 1886 | 3,750 | | |

### *Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $151.34 |
| Amount appropriated by act approved July 13, 1892 | 2,500.00 |
| | 2,651.34 |
| June 30, 1893, amount expended during fiscal year | 1,818.33 |
| July 1, 1893, balance unexpended | 833.01 |
| Amount that can be profitably expended in fiscal year ending June 30, 1895<br>Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893. | 2,500.00 |

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### REPORT OF MR. B. F. THOMAS, ASSISTANT ENGINEER.

LOUISA, KY., *June 30, 1893.*

MAJOR: A party was sent out on Tug Fork in August, but on account of unusually low water only got to Pigeon Creek, 40 miles above here.

The following work was done:

| | | | | |
|---|---|---|---|---|
| Solid rock removed | Cu. yds | 206 | Trees removed | 55 |
| Loose rock removed | do | 4,018 | Stumps removed | 93 |
| Snags removed | | 130 | Trees topped | 2 |

This work was done at Mill Creek, Lost Creek, Falls of Tug, Copley Shoal, Bear Branch, Drag Shoal, Smith Shoal, Endicott Landing, Pack Branch, Endicott Shoal, Whitt Bar, Calf Creek Shallows, Bull Shoal, Turkey Shoal, Big Elk, Horns Milldam, Crums Milldam, Chaffins Landing, Romans Landing, Silver Creek Shoal, mouth of Jennies Creek, Stone Coal. Bowen Shallows, Sand Bar Bend, Lick Shoal, Marrow Bone, Buck Creek Shoal, Collins Creek, Burning Creek, Wolf Creek, Wolf Shoal, Sand Gut, Yosie Sluice, Pasleys Shoal, Long Branch Shoal, Carters Ripples, and Pigeon Shoal.

The improvement at Wolf Shoal is particularly noticeable, the shoal being well cleaned out its entire length of over a half mile and a wall having been built along the chute.

The work was in charge of Capt. James Welch of the steamer *Fairplay*.

Respectfully submitted.

B. F. THOMAS,
*Assistant Engineer.*

Maj. D. W. LOCKWOOD,
*Cincinnati, Ohio.*

NOTE.—The commercial statistics are included in the report for improving Big Sandy River, West Virginia and Kentucky.

## I I 12.

## IMPROVEMENT OF GUYANDOTTE RIVER, WEST VIRGINIA.

The Guyandotte River rises in the southwestern part of West Virginia, and, flowing in a northwesterly direction, empties into the Ohio 12 miles above the mouth of the Big Sandy and 39 miles below the mouth of the Great Kanawha.

The project for the improvement was adopted in 1878, and contemplated the obtaining of a clear channel with a width of 30 feet and a least depth of 18 inches during five months of the year by the removal of rocks, snags, and other obstructions. This river was practically closed before work commenced, except during rises of considerable height.

The stream was once improved by the State of Virginia by the construction of 6 locks and dams. The locks were constructed of timber, and, as a matter of course, after a time, the charges for repairs, rendered necessary by the natural decay of the wood, became very great, and a little farther along the system was abandoned, and what had formerly constituted a useful improvement now became obstructions. The old locks and dams were carried away in part from time to time by floods, so that when the first report on this river was made by Maj. William E. Merrill, in 1875, most of them had been partially washed away, but the ruins of one still constituted the worst obstruction on the river.

There are 2 milldams—Pecks, 7 miles below Logan, and Lamberts, 19 miles below Pecks—that still constitute serious obstructions to navigation, and have been reported to the Department as such. The authority for their construction in the first place was based upon a permit from the circuit court, and their continuance has been a nuisance and constant damage to the river interests.

The work in previous years has been to cut passage ways through the old dams where required, make channels through the shoals for push boats, and remove such obstructions as rocks, snags, stumps, logs, etc., existing in the channel of the river as would interfere with rafting at ordinary and low rafting stages. During the past year the work done has been with a view to assisting the running of rafts and steamboats during moderate rises.

The stream is incapable of permanent improvement, as the obstructions in the channel, such as trees, snags, logs, etc., are liable to re-form. The stream up to Logan, a distance of 81½ miles, has an average fall of about 22 inches to the mile.

For details concerning the work, attention is invited to the report of Assistant Engineer B. F. Thomas, attached hereto.

### APPROPRIATIONS.

| | | | |
|---|---|---|---|
| June 18, 1878 | $2,000 | August 11, 1888 | $2,000 |
| March 3, 1879 | 1,000 | September 19, 1890 | 2,000 |
| June 14, 1880 | 2,000 | July 13, 1892 | 2,000 |
| March 3, 1881 | 3,500 | | |
| August 2, 1882 | 2,000 | Total | 18,500 |
| July 5, 1884 * | 2,000 | | |

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* Made available by act of August 5, 1886.

### *Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $93.70 |
| Amount appropriated by act approved July 13, 1892 | 2,000.00 |
| | 2,093.70 |
| June 30, 1893, amount expended during fiscal year | 2,039.34 |
| July 1, balance unexpended | 54.36 |

{ Amount that can be profitably expended in fiscal year ending June 30, 1895 2,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

## REPORT OF MR. B. F. THOMAS, ASSISTANT ENGINEER.

LOUISA, KY., *June 30, 1893.*

MAJOR: Work upon Guyandotte River, West Virginia, was commenced in August with a small force of men, carrying the necessary tools and appliances upon a push boat, and living in a cabin built upon another push boat. The work was of the same general character heretofore done upon this stream, *i. e.*, the removal of snags from the chutes and of rocks from the bends and shoals, and topping of overhanging trees. The party remained upon the work till the first of June, when the funds gave out. Work was done at Barboursville, Vinsons, Toms Creek, Menetts Creek, Falls, Smith Creek, Rogers Dam, Davis farm, Salt Rock, Heath Creek, Witcher Turnhole, Russells Landing, Long Shoals, Chapmansville, Morrisons Landing, Crawleys Creek, Sycamore Bend, Pecks Dam, Muskrat Shoal, Green Shoals, Big Hart Creek, Lamberts Dam, Big Ugly, Big Aaron, Laurel Hill, Letart Falls, Ten Mile Bend, Bear Creek, Henchmans Bend, and other points. The following is a statement of quantities:

| | | | | |
|---|---|---|---|---|
| Solid rock removed | Cu. yds. | 350 | Trees removed | 611 |
| Loose rock removed | do | 2,045 | Stumps removed | 344 |
| Snags removed | | 499 | Trees topped | 153 |

The work done has greatly benefited navigation; and a steamboat much larger than any heretofore run makes regular trips during the winter and spring.

The recommendation made in my last report that the money appropriated for this river be for the purpose of purchasing or otherwise acquiring the dams, so that they can be removed, is renewed.

The work done in 1892 was superintended by Daniel Pigg and that just completed by Fred. McHenry.

Respectfully submitted.

B. F. THOMAS,
*Assistant Engineer.*

Maj. D. W. LOCKWOOD.

## COMMERCIAL STATISTICS.

*Commerce of Guyandotte River, West Virginia, for fiscal year ending June 30, 1893.*

| Articles. | 1891. | 1892. | 1893. |
|---|---|---|---|
| | *Tons.* | *Tons.* | *Tons.* |
| Cross ties | | 12,500 | 60,000 |
| Timber | 60,000 | 90,000 | 120,940 |
| Miscellaneous | 1,128 | 1,300 | 1,310 |
| Total | 61,128 | 103,800 | 182,250 |

*List of boats plying on Guyandotte River, West Virginia.*

[Character, sidewheel.]

| Name of boat. | Length. | Breadth. | Depth. | Tonnage. |
|---|---|---|---|---|
| | *Feet.* | *Feet.* | *Feet.* | |
| J. T. Hustler | 75 | 16 | 2.2 | 16.68 |

## I I 13.

## IMPROVEMENT OF LITTLE KANAWHA RIVER, WEST VIRGINIA.

The Little Kanawha drains the central portion of West Virginia, rising in Upshur County. Its course is a little north of west and it empties into the Ohio at Parkersburg; its total length is about 150 miles.

The Little Kanawha Navigation Company owns and operates four locks and dams on this river, which furnish slack-water navigation from the Ohio up to a point 2 miles above the village of Burning Springs, where the United States lock is located, but the service of this system is very poor, owing to the dilapidated condition of both locks and dams; breaks and washouts are of frequent occurrence during high water, and the interruption to navigation is, in consequence, expensive and harassing.

The present project for the improvement of this river, adopted in 1876 and modified in 1880, contemplates the construction of a lock and dam to extend slack-water navigation for a draft of 4 feet a distance of 12 miles above the point reached by the navigation company, and the improvement of the natural channel of the upper river by the removal of obstructions, etc., for a distance of 80 miles, the object of the latter being to obtain a channel of a minimum width of 40 feet with a depth of 2 feet for at least four months in each year.

The lock and dam, for extending slack-water navigation above the works of the Little Kanawha Navigation Company, are completed, the lock having been opened to navigation December 2, 1891. This gives, theoretically, 4 feet navigation to and a little above the mouth of the west fork. During the extreme low water of last year, however, although the pool above the lock was full at all times, there were times when the upper surface of the lower miter sill was out of water, owing to the fact that the dams of the navigation company were not tight; almost the entire low-water discharge of the river passed through the Palestine Dam, 9 miles below Burning Springs.

The work done during the past fiscal year was as follows:

Completing the backing of the dam and construction of the shore crib below lock, construction of a new lock-tender's dwelling, clearing up the land on lock side of river, grading the grounds, and sowing same with grass seed.

### APPROPRIATIONS.

| | | | |
|---|---|---|---|
| August 14, 1876 | $7,300 | August 5, 1886 | $16,875 |
| June 18, 1878 | 18,000 | August 11, 1888 | 25,000 |
| March 3, 1879 | 18,000 | September 19, 1890 | 40,000 |
| June 14, 1880 | 15,000 | | |
| March 3, 1881 | 40,000 | Total | 211,175 |
| August 2, 1882 | 31,000 | | |

*Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $3,509.40 |
| June 30, 1893, amount expended during fiscal year | 3,246.23 |
| July 1, 1893, balance unexpended | 263.17 |
| July 1, 1893, outstanding liabilities | 158.85 |
| July 1, 1893, balance available | 104.32 |

NOTE.—For commercial statistics and list of boats, see report for operating and care, etc., Little Kanawha River, West Virginia.

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## I I 14.

### OPERATING AND KEEPING IN REPAIR THE LOCK ON LITTLE KANAWHA RIVER, WEST VIRGINIA.

This lock, known as No. 5, is located about 42 miles from the mouth of the river and above the four locks and dams owned and operated by the Little Kanawha Navigation Company. It was opened to navigation December 2, 1891, and since that time has been in condition to be operated continuously, with the exception of one day, when, owing to the breaking of a bonnet on one of the gates, locking was suspended.

During the latter part of 1892 the company's dams below leaked so badly as to partially drain the pool, and navigation was suspended; at one time the top of the lower miter sill was 6 inches above the water surface, and already, during June, navigation has been suspended for lack of water. A slack-water system that fails to function during low water is simply an obstruction to navigation, as for ordinary stages the river would be navigable without the locks and dams, and at such times they are merely in the way. The pool above No. 5 was full throughout the year.

During the past year the lower step of the dam injured during the spring of 1892 by loose logs was repaired. The apron in the lower bay was removed and paved with large stones, and new screens were put in at upper ends of filling and emptying culverts.

Some slight damage has been done to the lower step this year by running loose logs.

Considerable washing has taken place in the banks below the lock and abutment, but this was to be expected from the change of conditions and does not affect the safety of the lock or dam. It is proposed to riprap the bank below the lower land crib, which will stop further erosion.

ALLOTMENTS.

| | |
|---|---|
| 1892 | $1,500.00 |
| 1893 | 4,426.65 |
| Total | 5,926.65 |

*Detailed statement of expenses incurred in preserving and maintaining portion of the Little Kanawha River, West Virginia, improved by loc the fiscal year ending June 30, 1893.*

| Months. | Salaries. | Labor and material. | C an ti ex |
|---|---|---|---|
| 1892. | | | |
| July | $95.00 | $2,013.37 | - |
| August | 95.00 | 564.95 | .... |
| September | 95.00 | .......... | .... |
| October | 95.00 | 896.79 | .... |
| November | 95.00 | 12.25 | |
| December | 95.00 | 274.69 | |
| 1893. | | | |
| January | 95.00 | .......... | |
| February | 95.00 | 26.51 | |
| March | 95.00 | .......... | .... |
| April | 95.00 | 8.50 | |
| May | 95.00 | .......... | .... |
| June | 95.00 | .......... | |
| Total | 1,140.00 | 3,297.06 | |

COMMERCIAL STATISTICS.

*Commerce of Little Kanawha River, West Virginia, for fiscal year end*

| Articles. | 1890. | 1891. |
|---|---|---|
| | *Tons,* | *Tons.* |
| Coal | 1,100 | 10,507 |
| Lumber | 8,540 | 28,677 |
| Oil | 678 | 1,450 |
| Staves | 24,500 | 26,964 |
| Timber | 70,000 | 59,703 |
| Ties, railroad | 27,650 | 48,312 |
| Passengers | 1,563 | 1,500 |
| Miscellaneous | 6,084 | 13.575 |
| Total | 140,115 | 190,688 |

*List of boats plying on Little Kanawha River, West Virgi*

[Character, stern wheel.]

| Name of boat. | Length. | Breadth. |
|---|---|---|
| | *Feet.* | *Feet.* |
| Oneida (packet) | 104 | 19.5 |
| W. A. Hilton (packet) | 105 | 22 |
| D. T. Watson (towboat) | 99 | 17 |
| J. King (towboat) | 66.5 | .......... |
| Mary E. (towboat) | 86 | 13.6 |
| Lulu F. (towboat) | 98.4 | 15.1 |

*Report of lockages on Little Kanawha River, West Virginia, for fiscal 30, 1893.*

| Lock. | Days operated. | Days suspended. | Going up. | | | Going down. | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Steamboats. | Barges and flats. | Miscellaneous. | Steamboats. | Barges and flats. | Rafts. | |
| No. 5 | 302 | 63 | 327 | 134 | 105 | 323 | 133 | 1,861 | 1 |

## I I 15.

### IMPROVEMENT OF BUCKHANNON RIVER, WEST VIRGINIA.

The project for the improvement of this stream, approved in 1884, is to clear out that portion of the river between the Three Forks and the town of Buckhannon, a distance of 24½ miles. The obstructions to be removed consist of log jams and bowlders of various sizes up to 500 cubic yards.

The project called for a channel 30 feet wide.

The object of the improvement was to facilitate the running of rafts by making it possible to bring them out on a lower stage than had been the case formerly.

Buckhannon River is a tributary of the Tygart Valley and rising in the southwestern part of Randolph County, W. Va., flows a little east of north until it empties in the Tygart Valley River in Barbour County. The distance from the Three Forks to the mouth is 47½ miles, and the total length of the stream is about 57 miles.

During the last fiscal year no work has been done, the balance of funds at the end of the last fiscal year, amounting to $17.22, not being sufficient to be of any avail.

In consequence of the fact that a logging road is being operated along this stream, no additional appropriation is required for the work, as, in the future, little if any timber will be brought out by water.

APPROPRIATIONS.

| | |
|---|---|
| July 5, 1884 | $1,500 |
| August 5, 1886 | 1,500 |
| August 11, 1888 | 1,500 |
| September 19, 1890 | 1,000 |
| Total | 5,500 |

*Money statement.*

| | |
|---|---|
| July 1, 1892, balance unexpended | $17.22 |
| June 30, 1893, amount expended during fiscal year | 17.22 |

NOTE.—It has been impossible to obtain any commercial statistics.

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## I I 16.

### PRELIMINARY EXAMINATION OF LICKING RIVER, KENTUCKY, WITH A VIEW TO PROVIDING SLACK-WATER NAVIGATION.

[Printed in House Ex. Doc. No. 57, Fifty-second Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
*Washington, D. C., December 5, 1892.*

SIR: I have the honor to submit the accompanying copy of report, dated October 17, 1892, by Maj. D. W. Lockwood, Corps of Engineers, of the results of a preliminary examination of Licking River, Kentucky, with a view to providing slackwater navigation, made to comply with provisions of the river and harbor act approved July 13, 1892.

It is the opinion of Major Lockwood, concurred in by the division engineer and by this office, that the river is not worthy of improvement by the General Government in the manner proposed.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
*Brig. Gen., Chief of Engineers.*

HON. S. B. ELKINS,
*Secretary of War.*

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### REPORT OF MAJ. D. W. LOCKWOOD, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
*Cincinnati, Ohio, October 17, 1892.*

GENERAL: I have the honor to submit the following report of a preliminary examination of the Licking River "with a view of providing slack-water navigation," in compliance with the requirements of Department letter of July 14, 1892.

The Licking lies wholly in the State of Kentucky, and rises in the southeast corner of the State, its head waters being within about 20 miles of the Cumberland Mountains, the boundary between Kentucky and West Virginia; its length is about 350 miles, and it has been surveyed for a distance of 297 miles from its mouth.

It was first surveyed in 1829 from its mouth to Slate Creek, a distance of 149 miles, by Lieuts. Turnbull and Grayson. In 1836 and 1837 this survey was extended by N. B. Buford, for the State of Kentucky, to West Liberty, a distance of 82 miles, and in 1878 the survey was still further extended, under the direction of Maj. William E. Merrill, Corps of Engineers, to Trace Creek, a distance of 66 miles.

During the winter of 1886–'87 a preliminary examination of the stream between Farmers and West Liberty was made under the direction of Maj. James C. Post, Corps of Engineers.

In 1837 the State of Kentucky began the improvement of the Licking by locks and dams, and contracts were let for five locks. In 1839 contracts were let for two additional locks. In 1840 work was suspended for lack of funds, and in 1842 a final settlement was made with the contractors. The total cost to the State was $372,520, all of which was a total loss.

The original project under which the old State locks were started called for the following dimensions of locks up to the Lower Blue Lick, a distance of 98 miles: Length, 175 feet; width, 38 feet. From the Lower Blue Lick to West Liberty the locks were to be 120 feet long and 20 feet wide. As actually started the dimensions were a compromise between the two given, to wit, length, 150 feet; width, 31 feet.

The lifts of the seven locks started by the State varied from 15½ feet to 18 feet, and the dams were intended to be from 24 to 27 feet high. More recent investigation has shown that these lifts and heights of dams were excessive, and greater than the heights of the banks would warrant.

Granting that there are valuable deposits of coal and iron, and large tracts of valuable timber lands on the upper river, a careful examination of such information as I have been able to obtain shows that they are practically beyond the reach of slack-water navigation. Above Farmers it is estimated that the supply of water would be insufficient for about five months on an average in each year. In addition to this, the character of the upper river is such that only very small boats could be used. The assistant engineer who made the examination between Farmers and West Liberty stated that in this section there were places where a boat 60 feet long would have trouble in getting through on account of the sharp bends and narrow river. Coal and iron can not be moved economically on a slack-watered river under such conditions. Even as far up as the South Fork, 51 miles from the Ohio, it is questionable whether continuous navigation could be assured if locks and dams were constructed, for it must be borne in mind that the loss from evaporation will be very much greater from the pools than from the natural river.

The valley of the Licking is narrow and although very productive, its output, leaving out of account the coal, iron, and timber, which are above the reach of slack-water navigation, would hardly warrant the large expenditure of money necessary to improve the river by locks and dams, even so far as Falmouth.

The difference of level between the Ohio and the Licking at Falmouth is 85 feet, and it is more than likely that an average lift of 10 feet to each lock is about all the banks would allow. This would require 8 locks to carry slack water to Falmouth. * * *

In view of all the conditions and circumstances I do not consider the Licking River worthy of improvement by providing slack-water navigation.

The commercial statistics for fiscal year ending June 30, 1892, of the river as far down as Farmers show a tonnage of 34,588 tons, of which 30,000 tons consisted of logs, 2,500 tons of railroad ties, and 175 tons of staves. It is estimated that 8,090,000 feet B. M. of logs passed Farmers for the lower river last year. There is a considerable commerce out of the extreme lower river into the Ohio, but this is affected more by the conditions existing at the mouth than it would be by any improvement above.

Very respectfully, your obedient servant,

D. W. LOCKWOOD,
*Major of Engineers.*

Brig. Gen. THOMAS L. CASEY,
*Chief of Engineers, U. S. A.*

(Through Col. O. M. Poe, Corps of Engineers, Division Engineer, Northwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
*Detroit, Mich., October 25, 1892.*

Respectfully forwarded to the office of the Chief of Engineers.

For the reasons assigned by the district engineer I concur in his opinion.

O. M. POE,
*Colonel, Corps of Engineers,*
*Division Engineer, Northwest Division.*

## I I 17.

## PRELIMINARY EXAMINATION OF THE BIG SANDY RIVER, KENTUCKY, FROM ITS JUNCTION WITH THE OHIO RIVER TO THE CROSSING OF THE BIG SANDY BY THE CHESAPEAKE AND OHIO RAILROAD BRIDGE, WITH A VIEW OF ASCERTAINING IF THERE BE A BAR IN THE OHIO RIVER AT THE MOUTH OF SAID BIG SANDY OBSTRUCTING NAVIGATION, AND IF THERE BE WHETHER BY CONFINING THE WATERS OF THE BIG SANDY TO THE GENERAL COURSE OF ITS CHANNEL BETWEEN SAID POINTS THE BAR WILL BE REMOVED.

[Printed in House Ex. Doc. No. 66, Fifty-second Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
*Washington, D. C., December 5, 1892.*

SIR: I have the honor to submit the accompanying copy of report, dated October 18, 1892, by Maj. D. W. Lockwood, Corps of Engineers, of the results of preliminary examination of Big Sandy River, Kentucky, from its junction with the Ohio River to the crossing of the Big Sandy by the Chesapeake and Ohio Railroad bridge, with a view of ascertaining if there be a bar in the Ohio River at the mouth of said Big Sandy obstructing navigation, and if there be whether, by confining the waters of the Big Sandy to the general course of its channel between said points the said bar will be removed.

This examination was made to comply with provisions of the river and harbor act approved July 13, 1892, and Major Lockwood is of opinion that the locality is not worthy of improvement by the General Government. His opinion is concurred in by the division engineer and by this office.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
*Brigadier-General, Chief of Engineers.*

HON. S. B. ELKINS,
*Secretary of War.*

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### REPORT OF MAJOR D. W. LOCKWOOD, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
*Cincinnati, Ohio, October 18, 1892.*

GENERAL: The river and harbor act of July 13, 1892, contained the following:

> SEC. 6. That the Secretary of War is hereby directed to cause preliminary examinations to be made at the following localities, to wit:
>
> * * * * * * *
>
> Big Sandy River from its junction with the Ohio River to the crossing of the Big Sandy by the Chesapeake and Ohio Railroad bridge, with a view of ascertaining if there be a bar in the Ohio River at the mouth of said Big Sandy obstructing navigation, and if there be whether by confining the waters of the Big Sandy to the general course of its channel between said points the said bar will be removed.

In compliance with Department letter of July 14, by which this examination was assigned to me, I have the honor to submit the following report:

The Big Sandy empties into the Ohio at Catlettsburg, 151¾ miles above Cincinnati. It is a stream that varies from a depth hardly sufficient to float a skiff to one at high water having a depth of upwards of 40 feet. From the junction of the Tug and Levisa forks, 26 miles above the Ohio, the banks of the Big Sandy are of sand easily washed. This is true also of the banks of the two forks after they leave the mountain country, and the result is that every rise in the Sandy or its forks carries with it large quantities of sand.

In consequence of the extreme variation in the discharge, the cross-section area of discharge must be such as to accommodate the high-water outflow, and when the river falls the low-water channel is cut out somewhere between the high-water banks, but its location may vary from year to year.

An examination of the locality when the Ohio and Sandy were both low developed the fact that there existed a bar in the Ohio below the mouth of the Sandy that extended out into the Ohio from 250 to 300 feet, and that the mouth of the Sandy had been crowded upstream by it, close under Virginia Point.

Supposing the Ohio and Sandy both high, a bar will necessarily be formed in the latter stream where its sand-laden water strikes the back water from the Ohio. The point at which this occurs will, of course, vary according to the relative heights of the two streams. The Sandy rises and falls much more rapidly than the Ohio, and low water may exist in the Sandy when the Ohio is still at a fair stage, and in such cases, the Ohio falling slowly, small rises in the Sandy operate to move its bar nearer the Ohio, until the Ohio reaches so low a stage that its current can not carry away the sand brought into it by the Sandy during its rises, and a bar is formed in the Ohio, as was the case this season, just below the mouth of the Sandy; and this bar will vary, a rise in the Sandy adding to it and a rise in the Ohio cutting it away.

Steamboatmen, raftsmen, and push boatmen stated to me that this year, with both streams low, there came a number of rises in the Sandy that would have permitted boats to go to the upper river if they could have gotten from the mouth to the Chesapeake and Ohio Railroad bridge, 6,500 feet above, and these people expressed the opinion that if parallel dikes were constructed from the bridge to the Ohio, so as to limit the low-water channel, this trouble would disappear. I am not of this opinion, however, as confining the water to produce a scouring effect would cause shoaling above the upper ends of the dikes, and so long as the current in the Ohio is too weak to carry away the sand that the Sandy brings out, there is sure to be a shoal at the mouth. Spur dikes in any event would be preferable to those proposed.

While the lower end of the low-water channel is over against Virginia Point, in high water the current sweeps along the front of Catlettsburg, washing the bank and endangering the safety of a part of the town.

When the board of internal improvements of the State of Kentucky were investigating the subject of slack watering various streams in Kentucky by locks and dams, between 1830 and 1840, they only recommended the improvement of descending navigation for this stream, in consequence of a condition of affairs at the mouth similar to those found to exist to-day, only in less degree, for clearing the banks of timber has added to the unfavorable conditions that even then existed.

I do not deem the locality worthy of improvement, for the reason that, in my opinion, the bar at the mouth must be removed by the action of the Ohio, and will generally exist when the Ohio is so low that its feeble current can not carry away the sand brought down by the Sandy, and at such times a rise in the latter but piles up more sand.

A blue print* giving the characteristics of the Big Sandy from the railroad bridge to the Ohio, and a tracing* of profile of lower part of Sandy, from the Bell survey of 1875, are forwarded in a separate package.

The blue print was made from a map compiled from data obtained from two to four years ago, and on it I have indicated the general location of the low-water channel as it existed at the time I made an examination of it during September.

The stage of water when the map was made was higher than when I made the examination, and the width of the stream was greater than it was as I saw it. I am indebted to Mr. W. W. Coe, chief engineer of the Norfolk and Western Railroad, for this map.

Very respectfully, your obedient servant,

D. W. LOCKWOOD,
*Major of Engineers.*

Brig. Gen. THOMAS L. CASEY,
*Chief of Engineers, U. S. A.*

(Through Col. O. M. Poe, Corps of Engineers, Division Engineer, Northwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
*Detroit, Mich., October 25, 1892.*

Respectfully forwarded to the office of the Chief of Engineers.

For the reasons assigned by the district engineer, I concur in his conclusion.

O. M. POE,
*Colonel, Corps of Engineers,*
*Division Engineer, Northwest Division.*

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* Not printed.

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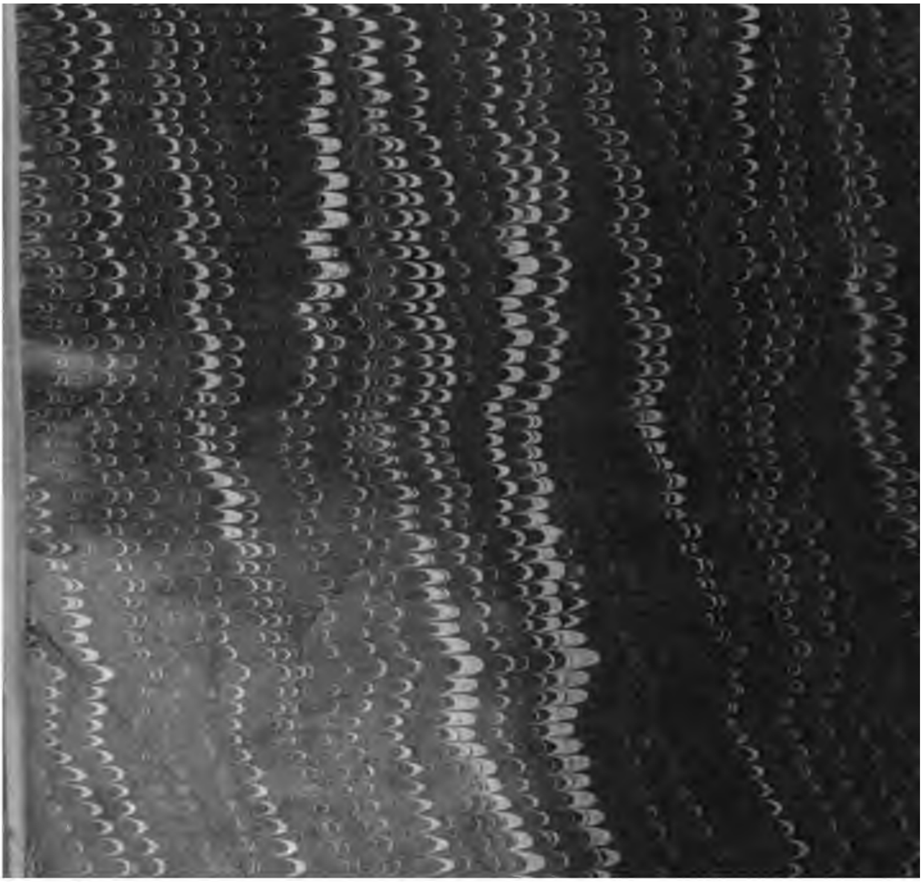

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